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THE MICROSCOPIC DETERMINATION OF THE NONOPAQUE MINERALS

BY

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CONTENTS.

ILLUSTRATIONS.

THE MICROSCOPIC DETERMINATION OF THE NONOPAQUE MINERALS.

By ESPER S. LARSEN.

CHAPTER I.—INTRODUCTION.

THE IMMERSION METHOD OF IDENTIFYING MINERALS.

Optical methods of determining minerals with the petrographic microscope have long been used and have been carried to a high state of development in studies of the minerals in thin sections of rocks and ores, yet out of about 1,000 mineral species comparatively few can be identified readily in thin sections. A mineral whose optical properties are known can be accurately and quickly identified, however, by the immersion method—that is, by immersing its powder in liquid media whose indices of refraction are known and determining its optical constants. In this bulletin the author gives a set of tables for the systematic determination of minerals from their optical constants, describes briefly some methods for the rapid determination of optical constants, gives the results of measurements of the optical constants of more than 500 species for which data was not previously available, and presents statistics on the optical properties of minerals.

The first tables prepared for general use in determinations of minerals by the immersion method were those of Van der Kolk,[1] published in 1900. Somewhat similar tables, prepared by A. F. Rogers,[2] were published in 1906, and an optical mineralogy containing tables and description of all minerals for which optical data were then available, prepared by N. H. and A. N. Winchell,[3] was published in 1909. However, the method has not received the attention that it deserves and has not come into general use, largely because the optical constants of over half the known minerals had not been determined.

NEW DATA.

In attempting to employ the immersion method some years ago the writer assembled all the data then available for its use with the petrographic microscope in determining minerals but found them so

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[1] Schroeder van der Kolk, J. C., Tabellen zur mikroskopischen Bestimmung der Mineralien nach ihrem Brechungsindex, Wiesbaden, 1900; 2d ed., revised and enlarged by E. H. M. Beekman, 1906.

[2] Rogers, A. F., School of Mines Quart., vol. 27, pp. 340-359, 1906.

[3] Winchell, N. H. and A. N., Elements of optical mineralogy, D. Van Nostrand Co., 1909.

incomplete that the method was applicable to but few species. Since then he has measured the chief optical constants of over 500 mineral species for which the data were lacking or incomplete, so that such data are now lacking for only about 30 very rare species. No attempt at great accuracy was made in these measurements, and comparatively few of the specimens studied represented analyzed minerals. Only a small number of minerals of many isomorphous series were examined, in some series only a single member.

NEED OF FURTHER DATA.

Much further work on the optical constants and more complete and accurate data on nearly all the minerals are needed, as well as detailed studies of isomorphous series and of the effect of solid solution. Another need is a fuller appreciation of the fact that most minerals are of variable chemical composition and therefore have variable optical and other properties. The science of mineralogy needs also good connected and consistent data on minerals. Chemical analyses, crystallographic studies, and determination of physical properties, optical constants, and paragenesis should be made on identical material. A highly accurate determination of the optical or other constants of a mineral is of comparatively little value unless the data obtained are definitely tied to a chemical analysis. Greater care should be taken in examining minerals for lack of homogeneity, whether it is due to zonal growths or to admixed or included foreign material. As few specimens of minerals are entirely free from foreign bodies and without zonal growths or other elements of heterogeneity no description of a mineral is adequate which does not show clearly that its material has been carefully examined microscopically. Every published analysis of a mineral should include a clear statement of the approximate amount and the character of the foreign material it contains and of the degree or extent of zonal growths or other elements of heterogeneity, and this statement should be the result of a careful microscopic examination of a sample of the same powder that furnished the material for the chemical analysis.

ADVANTAGES OF THE IMMERSION METHOD.

For determining the nonopaque minerals the immersion method has many advantages over other methods. It appears to excel greatly the ordinary blowpipe methods in rapidity and accuracy, and the quantity of material required is less than that required for tests by any other method. One who has acquired the requisite skill can measure the principal optical constants of a mineral in about half an hour, and most minerals can be determined by partial measurements in less time. In accuracy the method is nearly as reliable as a complete chemical analysis, for it is about as common for two or more minerals to have the same chemical composition as for two or more minerals to have the same optical constants. All the optical properties of a mineral can usually be determined from a single grain or crystal large enough to handle with a pair of delicate pincers, and in addition the material can be examined for homogeneity when the tests are made. Lack of homogeneity in material studied is one of the chief sources of error in mineralogic work.

The skill required to measure the optical constants is little if any greater than that required to do reliable blowpiping. The worker must have a good knowledge of optical mineralogy, such as may be gained by any good course in microscopic petrography, and some special training in the manipulation of immersed grains of minerals. The only equipment required is a good petrographic microscope and a few inexpensive liquids whose indices of refraction are known.

OTHER SUGGESTED USES FOR THE METHOD.

The optical method might be used with advantage in work done in a number of other branches of science than mineralogy and in some industries. It should be much more generally used in chemistry, especially in analyses of artificial crystalline products, to determine rapidly the exact nature of the material and its homogeneity, for artificial products have as definite optical constants as minerals. It should also be found valuable in many metallurgic processes, as well as in the cement and ceramic industries and other industries in which a knowledge of the exact nature of any material is desirable.

WORK AND ACKNOWLEDGMENTS.

The writer began his work on the tables in 1909, intending to measure the constants of only a few of the commoner minerals, but the desirability of having optical data on all the recognized species of minerals became so apparent that he afterward undertook the task of making all the measurements desired. Most of the work was done in the laboratory of the United States Geological Survey at Washington, D. C., but a considerable part was done at the University of California at Berkeley, Calif., during the winter of 1914–15. To measure the optical constants of 500 selected minerals is no great task, but difficulties appeared continually as the work progressed, owing to the frequent necessity of selecting suitable material from specimens consisting largely of other minerals, to the large number of specimens that were found to be incorrectly labeled, and to the difficulty of procuring many rare minerals.

The writer wishes to express his sincere thanks to Messrs. H. E. Merwin and Fred E. Wright, of the Geophysical Laboratory, W. T. Schaller, of the Geological Survey, and E. T. Wherry, of the National Museum, for help and encouragement in the work. Thanks are due also to Messrs. Merwin and Schaller for critically reading the manuscript of this bulletin and offering many helpful criticisms and suggestions and for furnishing unpublished data on a number of minerals. The writer wishes also to express his appreciation of the generosity of the officials of a number of museums and of several private collectors of minerals in furnishing specimens of many rare and valuable minerals. He is especially indebted to Col. Washington A. Roebling, of Trenton, N. J., who very generously placed his remarkable collection at the writer's disposal; to the late L. P. Gratacap and the American Museum of Natural History; and to Dr. Edgar T. Wherry and the United States National Museum. He is also grateful, for many valuable specimens of the rarer minerals, to Prof. W. E. Ford and Yale University; Prof. Charles Palache and Harvard University; Prof. A. S. Eakle and the University of California; Prof. A. H. Phillips and Princeton University; Johns Hopkins University; Prof. Oliver C. Farrington and the Field Museum of Natural History; Mr. F. McN. Hamilton and the California State Mining Bureau; Mr. F. A. Canfield, of Dover, N. J.; Dr. Per Geijer, of Stockholm, Sweden; and Prof. A. Lacroix, of Paris.

CHAPTER II.—METHODS OF DETERMINING THE OPTICAL CONSTANTS OF MINERALS.

In this chapter the writer describes briefly the special methods which he has found most satisfactory for the rapid determination of the principal optical constants of minerals by the immersion method. The chapter is not intended to be a complete discussion of optical mineralogy, and in order to understand it properly, the reader should have an elementary knowledge of crystallography and of the methods of optical mineralogy.[4] Theoretical discussions are avoided as far as possible, and no attempt is made to describe the methods of measuring accurately the optical constants of minerals.[5]

THE CHIEF OPTICAL CONSTANTS AND THEIR INTERRELATIONS.

The significant fundamental optical constants of crystals are the principal indices of refraction, the crystallographic orientation of the directions of vibration corresponding to these indices of refraction, and the amount of absorption of light vibrating in these directions, all for one or more standard wave lengths of light. For most minerals some of the constants, particularly the last, are known only in a qualitative way. The other properties commonly mentioned among the optical constants—birefringence, optical character, optic axial angle, dispersion of the optic axes, dispersion of the bisectrices, extinction angle, color, and pleochroism—are fixed by the fundamental constants and are significant only because they are often easily measured or estimated under the microscope.

Different symbols are used by different writers in referring to certain optical properties. Those used here are perhaps as commonly used as any in the textbooks listed below.[4] Refractive indices α,

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[4] Iddings, J. P., Rock minerals, John Wiley & Sons, 1911. Weinschenk-Clark, Petrographic methods, McGraw-Hill Book Co., 1912. Johannsen, A., Determination of rock-forming minerals, John Wiley & Sons, 1908. Winchell, N. H. and A. N., Elements of optical mineralogy, D. Van Nostrand Co., 1909. Groth-Jackson, Optical properties of crystals, John Wiley & Sons, 1910. Edwards, M. G., Introduction to optical mineralogy and petrography, Cleveland, Ohio, 1916. Finlay, G. I., Igneous rocks, McGraw-Hill Book Co., 1913. Luquer, L. M., Minerals in rock sections, D. Van Nostrand Co., 1905. Dana, E. S., A textbook of mineralogy, John Wiley & Sons, 1916. Moses, A. J., and Parsons, C. L., Elements of mineralogy, crystallography, and blowpipe analyses, D. Van Nostrand Co., 1916.

[5] A comprehensive treatment of the accuracy and limitations of the methods of optical mineralogy, based upon theory and checked by observations, is given by Fred. Eugene Wright in The methods of petrographic-microscopic research: Carnegie Inst. Washington Pub. 158, 1911. Albert Johannsen's Manual of petrographic methods, published by the McGraw-Hill Book Co., 1914, is an excellent compilation of the methods that have been proposed for optical measurements with the microscope. Rosenbusch's Mikroskopische Physiographie der Mineralien und Gesteine, Band 1, Erste Hälfte, by E. A. Wülfing, 1904, and Groth's Physikalische Krystallographie, 4th ed., 1905, are valuable books of reference, as is also Duparc and Pearce's Traité de technique minéralogique et pétrographique, pt. 1, 1909.

β, γ have directions of vibration X, Y, Z; birefringence is represented by B and equals $\gamma-\alpha$ or $\omega-\epsilon$ or $\epsilon-\omega$.

The relations that exist between the various optical properties are of considerable significance, and the author believes that they are not sufficiently emphasized in the textbooks nor are they kept clearly enough in mind by workers in optical mineralogy. The best available data on over 30 mineral species, or nearly 10 per cent of those for which data were available, can be seen at a glance to be strikingly inconsistent, and this happens even where the data appear to have a high degree of accuracy. The following examples will serve to illustrate:

Leucosphenite is said to be optically negative, but the values given for the indices of refraction ($\alpha_y=1.6445$, $\beta_y=1.6609$, $\gamma_y=1.6878$) are those of an optically positive mineral. Tests by the author show that leucosphenite is optically positive.

Lawsonite is stated to have the following properties: $\alpha=1.6650$, $\beta=1.6690$, $\gamma=1.6840$, $2V=84°\ 6'$, optically +. The axial angle, as computed from the indices of refraction, is $2V=54°$. It seems probable that the axial angle is correct and that β should be about 1.6735.

The relation between the axial angle (2V) and the indices of refraction is expressed by the equation:[6]

$$\text{Cos}^2\ V_\alpha=\frac{\gamma^2(\beta^2-\alpha^2)}{\beta^2(\gamma^2-\alpha^2)}\ \text{or}\ \tan^2 V_\alpha=\frac{\frac{1}{\alpha^2}-\frac{1}{\beta^2}}{\frac{1}{\beta^2}-\frac{1}{\gamma^2}}$$

The approximate formula[7]

$$\text{Cos}^2\ V_\alpha=\frac{\beta-\alpha}{\gamma-\alpha}$$

holds fairly well if the axial angle is small or the birefringence not too strong. The error in V'_α, as computed from the approximate formula, is shown in figure 1. The calculated value of V'_α is along the abscissa, and the correction to be added to this value is along the ordinate. For all the curves the value of α is 1.500, and each curve is for a particular value of $\gamma-\alpha=B$. The curves can be used to correct calculations made by the approximate formula. In the accurate equation α, β, or γ appear in the same power in both the numerator and denominator, so that the value of the equation will not be changed if they are replaced by $\frac{\alpha}{k}$, $\frac{\beta}{k}$, and $\frac{\gamma}{k}$. Hence to apply

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[6] For the development of this equation see Johannsen's Manual of petrographic methods, p. 103, 1914; Rosenbusch (Wülfing) Mikroskopische Physiographie, Band 1, Erste Hälfte, p. 96, 1904; Groth-Jackson, Optical properties of crystals, p. 143, 1910; Duparc and Pearce, Traité de technique minéralogique et pétrographique, pp. 78–80, 1907. For tables and a graphic solution of this equation see Wright, F. E., Graphical methods in microscopical petrography: Am. Jour. Sci., 4th ser., vol. 36, pp. 517–533, 1913.

[7] For a graphic solution of this equation see Wright, F. E., The methods of petrographic-microscopic research: Carnegie Inst. Washington Pub. 158, pl. 9, 1911.

the correction from the curves to a crystal with α different from 1.500 it is necessary to calculate $B' = \frac{1.500}{\alpha}(\gamma - \alpha)$. The value of B' need be calculated only approximately. To get the correct value of V_α from the indices of refraction the approximate value V'_α should be found from the equation $\text{Cos}^2\, V'_\alpha = \frac{\beta - \alpha}{\gamma - \alpha}$ or from the graph; then $B' = \frac{1.50}{\alpha}(\gamma - \alpha)$ and from these two values the correction to be added to V'_α may be read from figure 1.

The formulae given above indicate the value for the angle about α, which may be either the acute bisectrix (Bx_a) or the obtuse bisectrix (Bx_o). By definition, if α is the acute bisectrix (Bx_a) the mineral is optically negative and $2V_\alpha$ is less than 90° ($V_\alpha < 45°$). As tan 45° = 1, a mineral is optically negative if $\frac{1}{\alpha^2} - \frac{1}{\beta^2} > \frac{1}{\beta^2} - \frac{1}{\gamma^2}$ and optically positive if $\frac{1}{\alpha^2} - \frac{1}{\beta^2} < \frac{1}{\beta^2} - \frac{1}{\gamma^2}$.

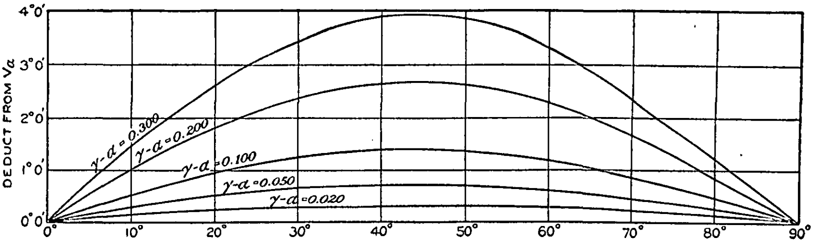

FIGURE 1.—The error in V'_α as computed from the approximate formula $\text{Cos}^2\, V'_\alpha = \frac{\beta - \alpha}{\gamma - \alpha}$.

$\text{Cos}\, 45° = \frac{1}{\sqrt{2}}$ for an optically negative mineral from the approximate formula

$$\sqrt{\frac{\beta - \alpha}{\gamma - \alpha}} > \frac{1}{\sqrt{2}}$$

or $2(\beta - \alpha) > (\gamma - \alpha)$ approximately.
Similarly for an optically positive mineral $2(\gamma - \beta) > (\gamma - \alpha)$ approximately.

These approximations hold only where the birefringence is not too strong. The following values of α, β, and γ are for crystals where $2V = 90°$ and show the increasing error in the approximations as the birefringence increases:

$\alpha = 1.5000$	$\beta = 1.5099$	$\gamma = 1.5200$
$\alpha = 1.5000$	$\beta = 1.5244$	$\gamma = 1.5500$
$\alpha = 1.5000$	$\beta = 1.5476$	$\gamma = 1.6000$
$\alpha = 1.5000$	$\beta = 1.5906$	$\gamma = 1.7000$
$\alpha = 1.5000$	$\beta = 1.6297$	$\gamma = 1.8000$

The axial angle is commonly measured in air, and the apparent axial angle so measured (2E) has the relation to the true axial angle 2V expressed by $\sin E = \beta \sin V$, where β is the intermediate index of refraction of the mineral.[8]

In the preceding equations the values are given for light of a particular wave length. As the wave length varies the indices of refraction and consequently 2V will vary, and even the optical character may change. This variation is called the dispersion of the optic axes, and 2V may be given for different colors or it may be given for one color—commonly the yellow light of sodium—and the variation with color may be expressed by $\rho < v$ (or $\rho > v$), meaning simply that the axial angle is less (or greater) for red than for violet.

Not only do the values of the indices of refraction change with the color of light, but the positions of two of the directions X, Y, and Z in monoclinic and of all three in triclinic crystals change—that is, the extinction angles vary with the color of light. This variation is called dispersion of the bisectrices. Crossed, horizontal, and inclined dispersion are simply phenomena due to dispersion of the bisectrices as observed on the interference figure.

MEASUREMENT OF INDICES OF REFRACTION.

The indices of refraction of a mineral can be measured most conveniently and accurately on a polished surface with the total refractometer or somewhat less conveniently on specially prepared and oriented prisms by the method of minimum deviation. Most minerals are not suitable for measurement by either of these methods, either because suitable plates or prisms can not be prepared or because the mineral is zoned and so differs in its optical properties at least as much as the error in the less accurate but much more rapid embedding method.

THE EMBEDDING METHOD.

Fairly accurate measurements of the principal indices of refraction can be made on a very small quantity of mineral by embedding the powdered grains in media whose indices of refraction are known and comparing and matching the indices of the media with each of those of the mineral by either the method of central illumination or the method of oblique illumination. The method of oblique illumination is best used with an objective of low or moderate power and can therefore be applied to a large number of grains very quickly. The method of central illumination is best used with an objective of moderate or high power.

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[8] For a graphic solution of this equation see Wright, F. E., op. cit., pls. 7 and 8, 1911.

THE METHOD OF OBLIQUE ILLUMINATION.[9]

The index of refraction of a grain embedded in a liquid or other body and that of the embedding material can be quickly compared by observing their line of contact under the microscope and shading a part of the field by placing the finger or a card beneath the condenser system, by tilting the mirror, or in some other way. A number of devices have been recommended for this purpose, and some of the newer microscopes have special slides inserted. The observation is best made with a low or moderate power objective and without the condenser lens. With a low-power objective a mineral that has a decidedly higher index than the liquid will have a dark border toward the shaded side of the field and a bright border on the opposite side. If the grain has a decidedly lower index of refraction the phenomena are reversed and the bright border is on the shaded side of the field. With the moderate-power objective and the condenser lens the phenomenon depends on the position of the condenser. If the focus of the condenser is above the object the phenomena are as stated above; if below the slide, the phenomena are reversed. It is best to check the system used by making the test on some known grain; a thin section in which orthoclase, quartz, or some other known mineral is in contact with Canada balsam is good for this purpose. At the same time the difference in index of refraction between the grain and liquid can be estimated by the relief and the amount of shading required to bring out the relief. This method is equally well adapted to thin sections and has many advantages over the Becke method or the method of central illumination, as it can be used with a low-power objective, and by it every grain in contact with the Canada balsam can be compared with balsam in a very short time.

For simplicity, the grain may be considered isotropic. If monochromatic, light is used, and if the grain and liquid have the same index of refraction for that light and are clear and colorless the grain will completely disappear. As most of the liquids commonly used have a stronger dispersion than most minerals, if the mineral and liquid have the same index for sodium light the mineral will have a higher index for the red end of the spectrum and a lower one for the blue. Hence, if white light is used there is a concentration of reddish light on one side of the grain and of bluish light on the other side. For some of the immersion materials—notably cinnamon oil—the dispersion is very great and strongly colored borders are present even where the index for sodium light of the grain and the liquid differ in the second decimal place. The relative indices must be judged from the intensities of the colors. In order

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[9] Wright, F. E., The methods of petrographic-microscopic research: Carnegie Inst. Washington Pub. 158, pp. 92-95, 1911.

for the worker to become familiar with the color phenomena under various conditions it is well to immerse grains with known indices of refraction in oils of known indices of refraction. For this purpose ω of quartz or of calcite is constant.

THE METHOD OF CENTRAL ILLUMINATION.

As the immersion method is ordinarily used nearly all fragments are thinner on the edges than in the center, and if the fragments differ from the surrounding material in refractive index they will act as small imperfect lenses toward a beam of nearly parallel light emerging from the condenser. If such a lenticular fragment has a higher index of refraction than the embedding medium it tends to focus the light above its plane, and if the microscope is first focused on the grain and then raised above focus the interior of the grain will appear more highly illuminated. As the microscope tube is raised higher above focus this highly illuminated area contracts and becomes brighter—a bright line moves into the grain. If the tube is lowered below focus the grain appears less highly illuminated than the rest of the field and a highly illuminated halo surrounds it. As the tube is lowered this halo moves out from the grain.

If the grain has a lower index of refraction than the embedding medium it will have a virtual focus below its plane, the phenomena are reversed, and the grain becomes centrally illuminated as the microscope tube is lowered below focus.

In practice the test is best made with an objective of medium or high power—one with 8-millimeter focus gives good results. The condenser may be in or out. The condenser system may be lowered or the lower diaphragm closed. The most suitable arrangement for a particular microscope and lens system can best be found by testing it with grains embedded in media of known indices of refraction.

IMMERSION MEDIA.

GENERAL FEATURES.

Immersion media should be nearly colorless, chemically stable, and without disagreeable odor or other objectionable properties. They should not dissolve or react with the mineral to be immersed. Low volatility and for many purposes a moderate though not too great viscosity are desirable. Each liquid should be miscible with the liquids whose indices of refraction are above and below it, and two liquids that are to be mixed should have approximately the same rate of volatilization, as otherwise the mixture may change rapidly. The index of refraction should not vary too greatly with changes of temperature. A low dispersion is desirable for accurate work, but a rather strong dispersion facilitates rapid determination.

The author has found the set of media given in Table 1 satisfactory, and it covers the range of nearly all the minerals.

Satisfactory liquids cover the range of indices of refraction up to 1.87 and above that point low-melting mixtures that remain amorphous on cooling may be prepared which cover the range up to $n_{\mathrm{Li}} = 3.17$. The values for the indices of refraction (n) are for sodium light except where noted for the sulphur-selenium and selenium-arsenic selenide melts and are those determined by the author at about 20° C. for liquids purchased in the ordinary market. In the column marked $\frac{dn}{dt}$ is given the change in the index of refraction for each degree centigrade change in the temperature. For all the media given the index of refraction decreases as the temperature increases. These values are mostly taken from the literature. The liquids are rather inexpensive, excepting methylene iodide. All the liquids, except as noted, will form suitable mixtures with those above and below in the table in all proportions. Amyl alcohol is unfortunately a solvent for a number of the minerals that have indices of refraction within its range, and measurements with it must be made rapidly.

TABLE 1.—*Refractive indices of immersion media.*

	n at 20° C.	$\frac{dn}{dt}$	Dispersion.	Remarks.
Water	1.333	Slight		Dissolves many of the minerals with low indices.
Acetone	1.357		Slight	Do.
Ethyl alcohol	1.362	0.00040	do	
Ethyl butyrate	1.381		do	
Methyl butyrate	1.386		do	
Ethyl valerate	1.393		do	
Amyl alcohol [a]	1.409	0.00042	do	Dissolves many minerals with which it is used.
Kerosene	1.448	0.00035	do	
Petroleum oil: [b]				
Russian alboline	1.470	0.0004	do	
American alboline	1.477	0.0004	do	
Valvolene [c]	1.502	0.0004	do	Will not mix with clove oil.
Clove oil [d]	1.531	0.00050	Moderate	Will mix with petroleum oil.
Cinnamon oil [e]	1.585 to 1.600	0.0003	Strong	
Cinnamon oil from Ceylon	1.595	0.0003	do	
Cinnamic aldehyde	1.614 to 1.617	0.0003	do	
α Monobromnaphthalene [f].	1.658	0.00048	Moderate	
Methylene iodide	1.737 to 1.741	0.00070	Rather strong.	Rather expensive. Discolors on exposure to light, but a little copper or tin in the bottle will prevent this change.
Methylene iodide saturated with sulphur.	1.778		do	
Methylene iodide, sulphur, and iodides. [g]	1.868		do	
Piperine and iodides	1.68 to 2.10			
Sulphur and selenium	1.998_{Na} to 2.716_{Li}		Very strong.	
Selenium and arsenic selenide.	2.72 to 3.17_{Li}		do	

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[a] Ordinary fusel oil may be used, but on mixing with kerosene it forms a milky emulsion, which settles on standing, and then the clear liquid may be decanted off.

[b] Any of the medicinal oils may be used, such as Nujol.

[c] Any good, clean lubricating oil, such as is used in automobiles, may be used.

[d] If clove oil does not mix with petroleum oil mix it with rapeseed oil, $n = 1.471$.

[e] The only advantage in using cinnamon oil is that it is less expensive than cinnamic aldehyde.

[f] Mixtures of clove oil and α monobromnaphthalene give a set of liquids of lower dispersion than those with cinnamon oil.

[g] To 100 grams methylene iodide add 35 grams iodoform, 10 grams sulphur, 31 grams SnI_4, 16 grams AsI_3, and 8 grams SbI_3, warm to hasten solution, allow to stand, and filter off undissolved solids. See Merwin, H. E., Media of high refraction: Washington Acad. Sci. Jour., vol. 3, pp. 35–40, 1913.

For fairly accurate work it is desirable to have a set of liquids from $n = 1.400$ to $n = 1.87$, differing from each other by 0.010, and a set of the solid media to carry the series up to $n = 2.72$, the index of these media differing by 0.020. For less accurate work the set can be reduced to suit the requirements. The most important range is from 1.45 to 1.87, as β for about 80 per cent of all the known nonopaque minerals falls within this range. There are only about eight minerals in which β is below 1.40 and only about 24 in which β is above 2.72. Care should be taken to prevent contamination and evaporation of the liquids. They are best kept in tall dropping bottles that have the combined ground stopper and dropper with glass cap. A 15 cubic centimeter bottle is the smallest that is kept in stock by dealers, and even that size is larger than is required for the ordinary amount of work. It is best to keep the bottles at least half full, but with methylene iodide economy may dictate the use of a smaller amount. The bottles should never be allowed to stand without the stopper and cap in place. A convenient and easily made case for the bottles is composed of a covered box that opens on hinges at one end. Ten bottles are kept in a 2-inch board which has 10 holes just large enough to hold the bottles. (See Pl. I.) The box is made to take as many of these boards with the bottles as desired. The box should be kept closed, as light affects some of the liquids, notably methylene iodide. Small glass tubes with glass rods inserted in the cork stoppers are satisfactory for liquids between 1.40 and 1.67.

With proper care a set of liquids made up as directed above will remain constant, within the limits of error required for most determinative work, for years. A set of 40 such liquids, used constantly for five years and checked once or twice a year, has rarely shown a change in any of the liquids of as much as 0.003. One or two liquids that have methylene iodide as a constituent were nearly all used up and had changed as much as 0.006. In general the liquids whose indices of refraction are above 1.75 are less constant.

The embedding media whose indices of refraction are above 1.87 are solid at ordinary temperature and are not quite so convenient nor accurate as are the liquids. They must not be heated too hot nor too long or they will change considerably. A small electric plate with three grades of heat is a convenient means for making embeddings with these melts. In practice a very small amount of the embedding medium is melted on a glass slip, a little of the powder to be examined is dusted into the melt, and a cover glass is pressed down upon it. In the highly colored melts that are rich in iodides or selenium the mineral must be powdered very fine, otherwise the thick film of the melt is nearly opaque.

PIPERINE AND IODIDES.[10]

Molten piperine dissolves the tri-iodides of arsenic and antimony and forms solutions that are fluid at slightly over 100° C. and are

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[10] Merwin, H. E., Media of high refraction for refractive index determinations with the microscope: Washington Acad. Sci. Jour., vol. 3, pp. 35–40, 1913.

CASE CARRYING DROPPING BOTTLES WITH INDEX OF REFRACTION MEDIA.

resin-like and amorphous when cold. To make such preparations having constant indices of refraction anywhere within the range $n=1.68$ to 2.10, mix three parts by weight of SbI_3 to one part of AsI_3, add this mixture to the piperine in the proper proportion, and heat carefully and stir in a test tube, large porcelain crucible, or glass flask just above the melting point of piperine until a homogeneous melt is obtained. A few grams of such a melt are sufficient for a large number of immersions. The heating may be done in a bath of crisco or paraffin, in an air bath, or over but not in the low flame of a bunsen burner or on an electric plate; stirring is essential to secure homogeneity. If the preparations are heated too hot the piperine is decomposed. The iodides should be examined under the microscope for impurities. Such preparations can be standardized on the goniometer by measuring a prism molded between two pieces of cover glass, or weighted quantities of the constituents can be used and the refractive indices of the resulting preparation obtained from figure 2. The indices of refraction of such media increase rather rapidly on standing, and they are not entirely con-

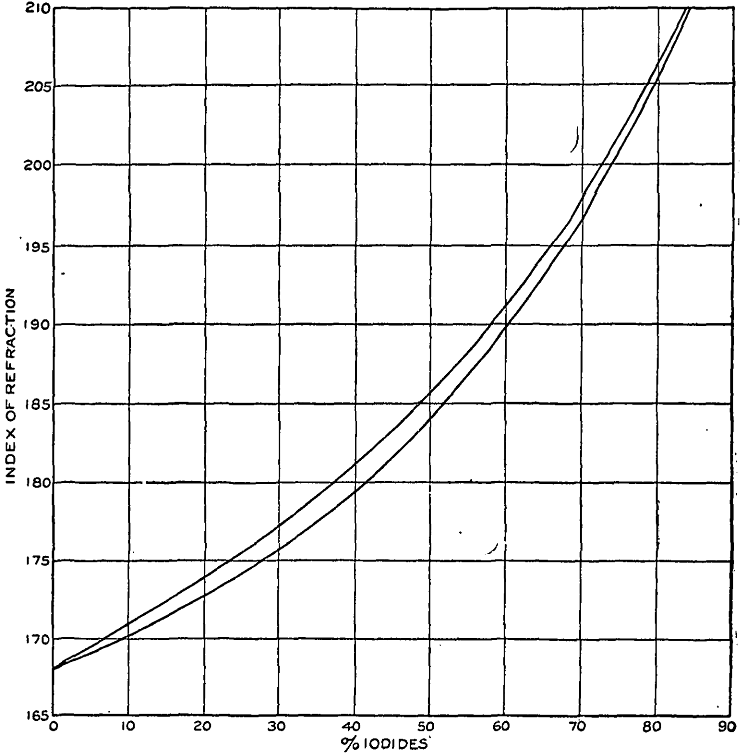

FIGURE 2.—Indices of refraction of mixtures of piperine and iodides.

stant for about a month.[11] The total increase in this time amounts to a few units in the third decimal place. After that time the indices remain constant and reheating does not affect them. In figure 2 curve *a* shows the indices of freshly made preparations and curve *b* the indices of the preparations after they have stood until constant. The indices of refraction as measured in white light in these melts (above $n=1.70$) are almost those for sodium light.

SULPHUR-SELENIUM MELTS.

Melted sulphur and selenium in any proportion readily form a homogeneous solution which has a constant index of refraction on cooling and remains amorphous long enough to allow measurements to be made. Suitable preparations with any index of refraction from 2.05 to 2.72 can be made by mixing the constituents in the proper proportion by weight and heating in a test tube just above the melting point until homogeneous. The mixture must be stirred and any sulphur that condenses on the upper part of the tube scraped back into the melt. The refractive indices for melts with different proportions of sulphur and selenium for light of different wave lengths are given in figure 3, and preparations having approximately any index of refraction can be made by using weighed quantities of the constituents.

The indices of refraction of melts that contain more than 50 per cent of sulphur differ considerably according to the treatment, and this difference, which is probably due to the presence of λ and μ sulphur in different proportions, increases with the amount of sulphur.[12] By high heating and quenching the index of refraction may even be raised 0.05 above that obtained by cooling in air. The proper treatment is to heat a small amount of the material on an object glass considerably above the melting point until the dark form of sulphur is obtained, then to add the mineral grains, press down a cover glass, and cool rather rapidly on a damp but not wet cloth or on an iron plate. It must also be remembered that sulphur is rather volatile. If the mineral to be tested is not decomposed by heating, it is well to mix the powdered embedding material and the mineral and to cover with a cover glass before heating, or to add the grains and cover before the final high heating. With proper care an accuracy of about ±0.01 can be attained.

Indices of refraction for sodium light below about 2.20 can be readily measured in the sulphur-selenium melts, but above that

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[11] For this and much other information about the preparation of melts for high index determinations I am indebted to a personal communication from Dr. H. E. Merwin.

[12] Merwin, H. E., and Larsen, E. S., Mixtures of amorphous sulphur and selenium as immersion media for the determination of high refractive indices with the microscope: Am. Jour. Sci., 4th ser., vol. 34, pp. 42–47, 1912.

point, on account of the deep-red color of the melts and the very strong dispersion of selenium, it is best to make the measurements for the red light of lithium. This operation can be easily done by placing over the eyepiece a color screen made by pressing a thin film of the melt composed of 70 per cent selenium and 30 per cent sulphur between two glass plates, as such a film transmits chiefly

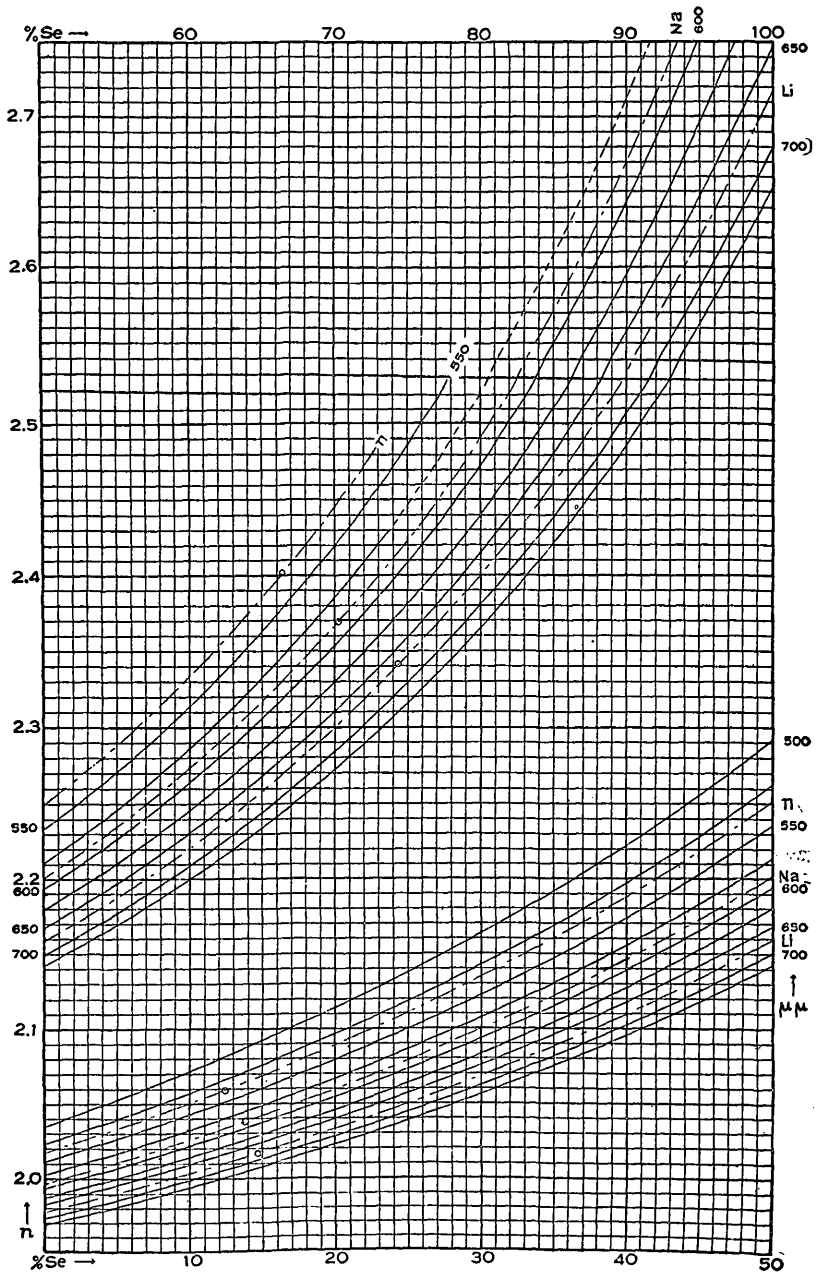

FIGURE 3.—Indices of refraction of mixtures of sulphur and selenium.

light that is about equivalent to lithium light. Such a film crystallizes very slowly. Mixtures containing over 70 per cent selenium transmit chiefly lithium light, and index measurements made in such mixtures with white light give nearly the indices for lithium light.

SELENIUM AND ARSENIC SELENIDE MELTS.

Dr. Merwin[12a] has found that mixtures of selenium and arsenic selenide cover the range of indices of refraction from $n_{Li} = 2.72$ to $n_{Li} = 3.17$. These mixtures melt at rather low temperatures and are generally satisfactory, although they are deeply colored and measurements must be made for red light. Measurements can be made with these mixtures with a probable error of less than 0.02, but only under the most favorable conditions. The mixtures can be made by heating together metallic arsenic and selenium in weighed quantities or by first making As_2Se_3 and then adding the proper proportion of selenium. Thorough stirring is necessary to insure homogeneous melts. The following table gives the indices of refraction for different wave lengths of light for several mixtures of selenium and arsenic selenide.

Indices of refraction for mixtures of selenium and arsenic selenide.

$\mu\mu$	Se.	60 per cent Se, 40 per cent As_2Se_3.	22.6 per cent Se, 77.4 per cent As_2Se_3.	As_2Se_3.
640	2. 78	2. 90	....	....
660	2. 74	2. 86	3. 06	....
680	2. 71	2. 83	3. 01	3. 17
700	2. 68	2. 80	2. 97	3. 13
720	2. 66	2. 77	2. 94	3. 10
740	2. 64	2. 75	2. 92	3. 07
760	2. 62	2. 73	2. 90	3. 05

Dr. Merwin has also informed me that a mixture of 10 per cent tellurium and 90 per cent As_2Se_3 gives indices of refraction 0.04 higher than the As_2Se_3 but is almost too opaque to use with an ordinary tungsten lamp. By means of direct sunlight or a "pointolite" lamp even more nearly opaque mixtures can be used.

METHODS OF STANDARDIZING MEDIA FOR MEASURING INDICES OF REFRACTION.

A number of methods of standardizing the embedding media by the microscope have been devised,[13] but the method that employs the total refractometer or the method of measuring minimum deviation with a prism are much more satisfactory, and with either method accuracy to a few units in the fourth decimal place is easily

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[12a] Merwin, H. E., private communication. The data are preliminary.

[13] Johannsen, Albert, Manual of petrographic methods, pp. 265–270, 1914. Wright, F. E., Measurement of the refractive index of a drop of liquid: Washington Acad. Sci. Jour., vol. 4, pp. 269–279, 1914.

attained. The refractometer may yield quicker results than the prism, but it can not be used with media whose indices are greater than about 1.86, and even with reasonable care it may be seriously injured by scratching or by corrosion from some of the liquids. The liquids containing methylene iodide in particular should not be allowed to remain on the hemisphere any longer than is necessary, and liquids from which crystals may separate should not be used, as the crystals may scratch the hemisphere.[14]

The method of minimum deviation with a prism is not quite so rapid as that with the refractometer, but it can be used for the whole range of embedding media.[15] Any hollow prism can be used, but suitable prisms can be quickly made from two optically true glass plates about 5 by 20 millimeters in size by fusing them together at one corner in a blast lamp, taking care not to bend the glass, so as to form a prism that has nearly the desired angle. About one in a hundred of a good grade of petrographic object glasses is suitable. The glasses can be very quickly tested by watching the reflection on all parts of the glass of a cord in front of a window at a distance of about 10 feet. If the two surfaces are not parallel two reflections will be seen; if they are not plane surfaces, the reflections will be distorted.

The unfused end of this prism can be pressed onto a small drop of melted soft glass and a base to the prism thus made. Surface tension will keep the liquids in place. Instead of being mounted on a glass base the prism may be mounted in plaster of Paris coated with dental cement to glaze it. The glass plates should fit closely together, and it is well to cement the contact on the outside with dental cement to make a tight joint.

Dr. C. S. Ross [16] has shown that better prisms can be made by grinding a piece of glass to a rough prism of any desired angle by measuring with a contact goniometer, grinding the edges of the two glass plates so that they will fit tightly together, and cementing the glass plates to the prism with bakelite so that a few millimeters of the glass plates will project above the top of the glass prism. The edges of the glass plates are also cemented with bakelite. It is convenient to have the top of the prism slope into the angle between the plates and thus make a tight receptacle for the drop of liquid.

A prism angle of about 60° is best for liquids that have moderate indices of refraction. A much smaller prism angle—one of 30° or

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[14] For a description of the crystal refractometer and its use see Rosenbusch (Wülfing), Mikroskopische Physiographie, Band 1, Erste Hälfte, pp. 218–222, 272–275, 1904. Groth, Physikalische Krystallographie, pp. 704–711, 1905. Duparc and Pearce, Traité de technique minéralogique et pétrographique, pp. 385–392, Leipzig, 1907.

[15] For a description of this method see Groth, op. cit., pp. 27, 690–696, 1905; Duparc and Pearce, op. cit., pp. 26, 369–376, or any textbook on light.

[16] Private communication.

less—must be used for liquids that have high indices of refraction. If a prism is to be used for a series of measurements a curve or a table should be constructed to show the index of refraction corresponding to any angle of minimum deviation. For the mixture of sulphur and selenium, the piperine preparations, or other solids, the prism can be molded between fragments of cover glass.

MEASUREMENT OF ALL INDICES OF REFRACTION OF CRYSTALS.

Most crystals have two (ω and ϵ) or three (α, β, and γ) principal indices of refraction, and for accurate work it is desirable to measure them all. If it is not necessary to measure all of the indices it is best to measure a particular one, preferably β, as otherwise any value from the lowest to the highest may be measured. If β is measured the others can be estimated from the birefringence and the axial angle.

The measurements of all the indices of refraction of a mineral can be made very quickly and within the limits of accuracy of the immersion method if the powdered grains show no marked tendency to lie on a particular face or cleavage, as do those of the micas, calcite, and many other minerals. Grains of minerals with such cleavages as the amphiboles, pyroxenes, and feldspars can generally be turned to any orientation without much difficulty. To test the lowest and the highest indices of refraction of such minerals against the embedding media a grain should be chosen that appears to show strong birefringence, both the thickness of the grain and the interference color being taken into account. The grain should be turned to extinction and tested against the embedding medium, then turned to the other extinction (or the lower nicol should be revolved 90°) and tested again. This procedure should be repeated on a number of grains, and with a little practice, unless the birefringence is extreme, many of them will show the lowest index of refraction, equal to α, or the highest index equal to γ, within the limits of error of the immersion method. For any grain or any orientation of a crystal plate β lies between the highest and the lowest values measured. Therefore β can be measured on a grain that shows no measurable birefringence. Such a grain is nearly normal to an optic axis and is suitable for observing the optical character, the size of the axial angle, and the dispersion of the optic axis. If the dispersion is considerable it will give abnormal interference colors without extinction.

Uniaxial minerals may be considered simply as a small group of biaxial minerals in which β is equal to α for a positive mineral and to γ for a negative one. The lowest index of every grain of a uniaxial positive mineral and the highest of a uniaxial negative mineral is equal to ω and can be measured on any grain.

It may be desirable to turn the grain over. This can be done by shifting the cover glass with the point of a pencil. The movement can be controlled better with a viscous immersion medium than with one that is very fluid. Small cover glasses are more satisfactory than large ones, as they are much more easily manipulated. A cover glass 11 millimeters in diameter, divided into quarters or even ninths, is most used by the author. By turning and transferring a single small crystal to different media all the optical properties can be measured.

Some grains may be conveniently oriented by observing interference figures. A section normal to the acute bisectrix will give β normal to the plane of the optic axes, and in that plane α for a positive mineral or γ for a negative mineral. A section normal to the obtuse bisectrix give β and γ or α; one parallel to the plane of the optic axes gives α and γ. Any section normal to the plane of the optic axes gives β.

Fibrous or prismatic fragments require a somewhat different treatment. If their extinction is nearly or quite parallel they will give one of the principal indices when turned with their length parallel to the plane of vibration of the lower nicol. The other two indices can be measured across the fibers by measuring a number of fibers, provided the mineral does not persist in lying on a particular face. In that event it may be necessary to roll a fiber, keeping it parallel to the cross hairs, and to observe the maximum or minimum index as it revolves. With a little practice this work can be done easily, unless the mineral is composed of very thin, broad laths. The face or cleavage on which a mineral tends to lie is likely to be normal to one of the principal optical directions. This tendency may be tested by an interference figure. On grains that show this tendency two of the indices of refraction can readily be measured and the other index can be obtained by turning the flake on edge.

Monoclinic minerals that are prismatic along (*c*) or (*a*) show parallel extinction for prisms that lie on any face parallel to crystal axis *b* and nearly the maximum inclined extinction if turned parallel to the face (010) which is normal to that axis. Prisms that lie on a face parallel to axis *b* will give for the ray vibrating across the prism the index of refraction (α, β, or γ) of the ray which vibrates parallel to axis *b*. Prisms that lie on the face (010) will give the other two indices of refraction and also the extinction angle, X (Y or Z) to *c* (or *a*). Triclinic fibers that have inclined extinction are more difficult to measure, but with a little ingenuity measurements can usually be made. The stronger the birefringence, however, the more accurate must be the orientation to obtain accurate results.

Platy minerals, such as mica, are more difficult to manipulate, and if their birefringence is considerable they require skill and patience in order to get good results. Fortunately in nearly all such minerals the rays corresponding to one index vibrate nearly or quite normal to the plate and those corresponding to the other two vibrate in the plane of the plate and can be easily measured. The index normal to the plate can be obtained by turning the plates and keeping them on edge; this can often be done in a viscous liquid or they may be measured as they are turned. It is sometimes helpful to mix a little powdered glass with the mineral or to have grains of varying size to separate the cover glass and object glass enough so that the mineral plates can turn over. One of two plates that are differently oriented and attached together may be more easily turned on edge. Many such minerals can be cut with a knife across the plates and the resulting fragments placed on the object glass in the position desired.

MEASUREMENTS OF AXIAL ANGLES.

The following methods of estimating or measuring the axial angle of mineral grains have been found most convenient by the author: (1) Observing the curvature of the hyperbola in sections cut nearly normal to an optic axis; (2) measuring or estimating the distance between the hyperbolas on a section cut nearly normal to the acute bisectrix; (3) computing the axial angle from the three indices of refraction.[17] All observations are best made on grains immersed in a medium that has an index of refraction approximately equal to that of β for the mineral.

From the curvature of the hyperbola of an interference figure the axial angle can be measured, under favorable conditions, with an error of $\pm 3°$.[18] With a little experience a rough estimate can be made by merely inspecting the curvature of the hyperbola. If the bar appears straight, when turned to the 45° position the axial angle is nearly 90° and as the curvature becomes greater the axial angle becomes smaller.

More accurate and rapid measurements can be made on sections approximately normal to the acute bisectrix, provided the axial angle is not so large that the hyperbolas are outside the field of the microscope. Measurements of the axial angle in air (2E), by using a cross-grating ocular, can be made on such sections in a few minutes with a probable error of only a few degrees.[18] A grain that is not well oriented can commonly be turned by carefully touching the cover glass.

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[17] For an excellent discussion of measurements of axial angles, see Wright, F. E., The methods of petrographic-microscopic research: Carnegie Inst. Washington Pub. 158, pp. 147–200, 1911.

[18] Wright, F. E., op. cit., pp. 155 et seq.

The axial angle can be computed from the values of the three indices of refraction according to the formula

$$\mathrm{Tan}^2\ V_\alpha = \frac{\frac{1}{\alpha^2} - \frac{1}{\beta^2}}{\frac{1}{\beta^2} - \frac{1}{\gamma^2}}$$

or by the approximate formula [19]

$$\mathrm{Cos}^2\ V_\alpha = \frac{\beta - \alpha}{\gamma - \alpha}$$

in which $2V_\alpha$ is the axial angle about α. For a discussion of these formulae see page 10. As the error in measuring the indices of refraction by the immersion method is considerable in comparison with the birefringence of most minerals, this method is very rough unless the birefringence is considerable.

DISPERSION OF THE OPTIC AXES.

The dispersion formula $\rho > v$ (or $\rho < v$) simply means that the axial angle is greater (or less) for red than for violet light. For rapid work the dispersion can best be observed on an interference figure which shows at least one optic axis well in the field of vision. For orthorhombic minerals or for monoclinic minerals in which the plane of the optic axes contains the crystal axis *b* both hyperbolas must show the same dispersion, but for other crystals the dispersion may be different for the two optic axes, and to determine definitely the dispersion both optic axes must be taken into account, or, better, the axial angles should be measured for different colors of light. For crystals in which both hyperbolas show the same dispersion, if $\rho < v$ is moderate the dark hyperbola should show on a sharp interference figure a faint but distinctly perceptible reddish color on the concave side and bluish on the convex side. These borders are reversed if $\rho > v$. If the dispersion is strong these borders become pronounced, and many minerals show no dark hyperbola but a series of colored ones. If the dispersion is extreme the interference figure can hardly be recognized in white light.

OPTICAL CHARACTER.

The optical character of a mineral can be conveniently determined on grains that show the emergence of the acute bisectrix, the obtuse bisectrix, either of the optic axes, or the optic normal (Y); it can also be determined from the values for the indices of refraction. In making any of the tests it is desirable to have the grains embedded in a medium that has an index of refraction nearly that of the β index of refraction of the mineral grain, as otherwise the interference

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[19] A graphic solution of this equation is given in Wright, F. E., op. cit., pl. 9.

figure will be distorted. Grains can be turned into the desired position by gently shifting the cover glass. In a viscous liquid, such as Canada balsam, even fibrous or micaceous minerals can readily be turned to any desired orientation. A few grains of powdered glass dusted through the embedding media will raise the cover glass so that the grains or fibers can be turned. Highly viscous liquids like Canada balsam or Peru balsam ($n = 1.593$) are good media in which to turn fibers on edge. Sections that show the emergence of an optic axis are by far the most serviceable, as they can easily be recognized by their interference colors, which are low to zero, and in minerals that have moderate or strong dispersion are abnormal. Moreover, in such sections the acute and obtuse bisectrices can be distinguished, unless the axial angle is very near 90°. The tests are made in the usual way. The author uses the red of the first order for most tests, but for minerals that are deeply colored, especially if they have very strong birefringence or if the grains are embedded in a deeply colored melt, the quartz wedge is more satisfactory. It is often convenient or even necessary to determine the position of the optic plane and make the test on the grain itself by observing an edge where it wedges out. The tests can be made without a wedge or plate by observing the indices in the two directions against the embedding media, provided it is between the two or near one of them.

The optical character can be determined from the indices of refraction. If $\beta - \alpha$ is decidedly greater than $\gamma - \beta$ the mineral is optically negative; if decidedly less it is positive. (See p. 11.) This relation should be used chiefly as a check on the other data, but for some fibrous minerals whose acute bisectrix is along the fibers it may be the only means of readily determining the optical character.

OPTICAL ORIENTATION, DISPERSION OF BISECTRICES, AND CRYSTAL SYSTEM.

Crystal habit and prominent cleavage, twinning, and other phenomena may be quickly observed under the microscope and their relations to the optical characters determined. By observing the interference figure the complete optic orientation of any grain, such as one lying on a cleavage or a crystal face, can be roughly made out. This observation is especially suitable for determining the optical position that corresponds to the direction normal to the grain. The orientation in the plane of the section can best be obtained by measuring extinction angles and determining the position of the slow ray and the fast ray by means of a red of the first order or a quartz wedge, or by testing the indices against the embedding medium. The dispersion of the bisectrices can be determined by measuring extinction angles in different colors of light. For ordinary purposes it is sufficient to observe the color phenomena in ordinary daylight when the crystal is near extinction. If the dispersion is slight the extinction should be sharp; if considerable there will be no sharp extinction but abnormal interference colors over a range depending on the extent of the dispersion.

It is commonly possible to determine the crystal system to which a mineral belongs from the microscopic study. The fact that minerals such as biotite may be sensibly uniaxial or may give sensibly parallel extinction introduces some uncertainty.

Isotropic minerals are amorphous or isometric. Uniaxial minerals are tetragonal or hexagonal. Biaxial minerals with parallel or symmetrical extinction are orthorhombic. Biaxial minerals with inclined extinction for fragments normal to one principal optical direction and parallel or symmetrical for those normal to the plane of the other two are monoclinic. Biaxial minerals with inclined or unsymmetrical extinction for all orientations are triclinic.

Monoclinic minerals elongated in the direction of crystal axes *a* or *c* can be conveniently examined by rolling the fragments. When such fragments are turned so as to give parallel extinction crystal axis *b* and one principal optical direction lie across the length. When the fragments lie on a face normal to crystal axis *b* they should show approximately the maximum extinction angle. In the conoscope an interference figure should also appear in the center of the field of the microscope. Such sections will give the characteristic extinction angle X (Y or Z) $\wedge c$ (or a). Pleochroism can be conveniently observed at the same time.

OTHER TESTS.

The optical properties are sufficient for the accurate determination of most minerals, but the occurrence and association of the mineral should be considered, a macroscopic examination made, and such simple properties as hardness noticed. It may be desirable also to determine the fusibility and the specific gravity or to make simple chemical tests. Microchemical examinations have not received the attention from mineralogists that they deserve.

CHAPTER III.—SOME STATISTICS ON THE OPTICAL PROPERTIES OF MINERALS.

DISTRIBUTION OF MINERALS WITH REGARD TO OPTICAL CHARACTER.

The tables in Chapter IV contain data for about 950 mineral species, but some species appear more than once, and there are about 1,200 entries. They are distributed as follows:

	Per cent.		Per cent.
Isotropic	16. 1	Biaxial+	28. 9
Uniaxial+	7. 7	Biaxial−	30. 0
Uniaxial−	13. 5	Optical character unknown	3. 8

Many of the isotropic minerals are amorphous and some minerals that are placed under the uniaxial groups are strictly biaxial but have small axial angles or their apparent uniaxial character is due to aggregate polarization of fibers or lamellae. A few of those included in the biaxial groups are uniaxial and appear biaxial on account of strain.

The small number of uniaxial positive minerals as compared with uniaxial negative minerals is noteworthy.

DISTRIBUTION OF MINERALS WITH REGARD TO INDEX OF REFRACTION AND BIREFRINGENCE.

The distribution of the minerals with regard to their intermediate index of refraction β is shown in figure 4. For only 10 minerals, or less than 1 per cent of the total number, is β less than 1.400, and for only about 28, or about 2 per cent, is β greater than 2.70. For about 54 per cent of all the minerals β is between 1.475 and 1.700.

The distribution of the minerals with respect to their birefringence is shown in figure 5. Curve 1 shows that the greater number of the minerals have a birefringence of about 0.018 and that the number rapidly decreases on both sides of this value. Curves 2 to 5 show the distribution as regards birefringence of the minerals whose indices of refraction β lie between certain values. The greater number of minerals in which β is lower than 1.80 have birefringence of about 0.015. For minerals in which β lies between 1.80 and 2.00 the greatest density of distribution is for a birefringence of about 0.035, and for those in which β is greater than 2.00 there is no marked maximum for the curve. These curves show a striking tendency for minerals which have high indices of refraction to have also strong birefringence. This tendency is equally well shown by the per-

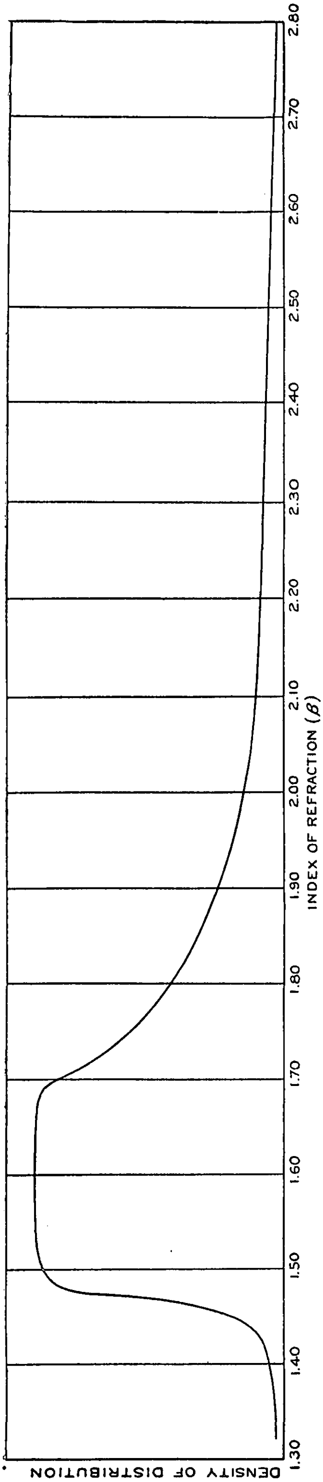

FIGURE 4.—Diagram showing density of distribution of the nonopaque minerals with respect to the intermediate index of refraction.

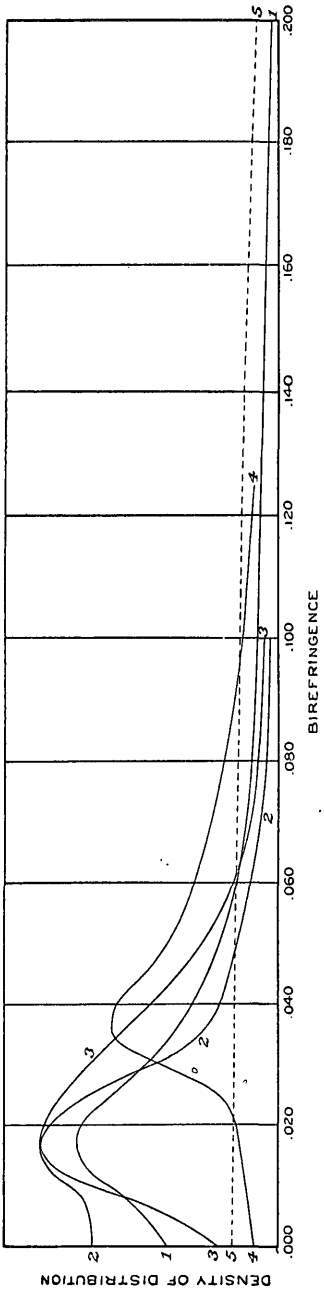

FIGURE 5.—Diagram showing density of distribution of the nonopaque minerals with respect to index of refraction and birefringence.

centage distribution of minerals which have birefringence greater than 0.20.

	Per cent.		Per cent.
β less than 1.80	1	β between 2.2 and 2.6	10
β between 1.80 and 2.0	11	β greater than 2.6	48
β between 2.0 and 2.2	14		

RELATION BETWEEN INDEX OF REFRACTION, DENSITY, AND CHEMICAL COMPOSITION.

Gladstone and Dale long ago showed that—

> Every liquid has a specific refractive energy composed of the specific refractive energies of its component elements, modified by the manner of combination, and which is unaffected by changes of temperature and accompanies it when mixed with other liquids. The product of this specific refractive energy and the density is, when added to unity, the refractive index.[20]

Or,

$$\frac{n-1}{d}=\mathrm{K}, \text{ and } \mathrm{K}=k\,\frac{p_1}{100}+k_2\,\frac{p_2}{100}+\text{etc.},$$

where K is the specific refractive energy of any substance and k_1, k_2, p_1, p_2, etc., are the specific refractive energies and the weight percentages of the components of that substance. These components may be the elements or radicals that enter into a compound or the constituents of a solution. In general these relations hold rather accurately for varying temperature, pressure, and concentration in liquids and gasses, but when applied to a substance in a different state—as liquid and gas—the formula gives errors as great as 30 per cent. On the basis of the electromagnetic theory of light Lorentz and Lorenz independently derived the formula $\frac{n^2-1}{n^2+2}\cdot\frac{1}{d}=k$. This formula holds somewhat better for substances in a different state but nevertheless gives a considerable error.

Moreover, some substances, as oxygen in some organic compounds, have two or more specific refractive energies, depending on the structure of the molecule.

When Gladstone's law is applied to crystalline substances the mean index of refraction $\frac{2\omega+\epsilon}{3}$ or $\frac{\alpha+\beta+\gamma}{3}$ must be used and the relations hold only approximately. The formula $\sqrt[3]{\omega^2\epsilon}$ or $\sqrt[3]{\alpha\beta\gamma}$, however, should be used where the birefringence is very strong. In applying these formulae to minerals, additional difficulties are introduced, as determinations of density are commonly unreliable, and the chemical composition of the material for which the indices

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[20] Gladstone, J. H., and Dale, T. P., Researches on the refraction, dispersion, and sensitiveness of liquids: Roy. Soc. London Philos. Trans., vol. 153, p. 337, 1864.

of refraction are available may be imperfectly known. However, the values shown in Table 2 for the specific refractive energies $\left(\frac{n-1}{d}=k\right)$ of the chief constituents of minerals have been computed by taking the average as derived from a number of minerals for which the available data seemed fairly reliable.

TABLE 2.—*Specific refractive energies* $\left(\frac{n-1}{d}=k\right)$ *of the chief constituents of minerals.*

	Molecular weight.	k.		Molecular weight.	k.
H_2O	18	[a] 0.335$_{Li}$,	As_2O_3	198	[g] 0.202, [h] 0.225
		[b] .340, [c] .354	Yt_2O_3	226	.144
Li_2O	30	.31	Sb_2O_3	228.4	[g] .209, [i] .232
$(NH_4)_2O$	52	.503	La_2O_3	326	.149
Na_2O	62	.181	Ce_2O_3	328.5	.16
K_2O	94	.189	Bi_2O_3	464	.163
Cu_2O	143	.250	CO_2	44	.217
Rb_2O	187	.129	SiO_2	60	.207
Ag_2O	232	.154	TiO_2	80	.397
Cs_2O	282	.124	SeO_2	111	.147
Hg_2O	416	.169$_{Li}$	ZrO_2	122.5	.201
Tl_2O	424	.120	SnO_2	151	.145
GlO	25	.238	SbO_2	152	.198
MgO	40.4	.200	TeO_2	159.5	[e] .200$_{Li}$
CaO	56	.225	ThO_2	264.5	.12
MnO	71	[d] .191, [e] .224	N_2O_5	108	.240
FeO	72	.187	P_2O_5	142	.190
NiO	75	.184	Cl_2O_5	151	.218
CoO	75	.184	V_2O_5	182.4	.43
CuO	79.6	[d] .191, [e] .253$_{Li}$	As_2O_5	230	.169
ZnO	81.4	[d] .153, [e] .183	Br_2O_5	240	.183
SrO	103.6	.143	Cb_2O_5	268	.295
CdO	128.4	.134	Sb_2O_5	320.4	.152, .222(?)
BaO	153.4	.127	I_2O_5	334	.177
HgO	216	.18	Ta_2O_5	446	.133
PbO	223	[d] .137, [e] .175$_{Li}$	SO_3	80	.177
B_2O_3	70	[g] .220	CrO_3	100	.36
C_2O_3	72	.265	SeO_3	127	.165
Al_2O_3	102	.193, [f] .214	MoO_3	144	.241$_{Li}$
Cr_2O_3	152	.27	TeO_3	175.6	.607
Mn_2O_3	158	[d] .300, [e] .304$_{Li}$	WO_3	235	.133
Fe_2O_3	160	[d] .308, [e] .36$_{Li}$	UO_3	286.5	.134

[a] Water and ice.
[b] Average.
[c] Alums, etc.
[d] Calculated from compounds containing the oxide.
[e] Calculated from the oxide.
[f] Calculated from feldspar, feldspathoids, etc.
[g] Isometric oxide.
[h] Monoclinic oxide.
[i] Orthorhombic oxide.

	Atomic weight.	k.		Atomic weight.	k.
H	1	1.256 or 1.44	S	32	[j] 0.502, [k] 1.00
C	12	.403	Cl	35.5	.303
O	16	.203	Br	80	.214
F	19	.043	I	127	.226

[j] Calculated from native sulphur.
[k] Calculated from sulphides; values vary.

These values are only approximate, but in a number of minerals selected at random the value of k as computed from n and d and as computed from that of its constituents agreed with few exceptions within 5 per cent. A very few minerals show a much greater difference.

As shown in the table for most radicals, the value of k is near 0.20. For S, $(NH_4)_2O$, TiO_2, TeO_3, and V_2O_5 it is higher, and for Cs_2O, BaO, PbO, ThO_2, UO_3, and F it is much lower. There is a tendency for the value of k in each group to decrease as the molecular weight increases, but there are many exceptions. The values of k for BaO, SrO, and CaO show why related minerals of these three oxides have about the same indices of refraction but very different densities. The values for Cb_2O_5 and Ta_2O_5 show why the columbates commonly have higher indices of refraction but lower densities than the corresponding tantalates. The extremely low value for fluorine accounts for the remarkably low indices of refraction and comparatively high densities of the fluorides.

Minerals containing any of the following radicals as essential constituents are likely to show strong dispersion: $(NH_4)O_2$, N_2O_5, UO_3, Sb_2O_5, As_2O_5, P_2O_5, V_2O_5, Fe_2O_3, Mn_2O_3, MoO_3, or TiO_2.

CHAPTER IV.—MEASUREMENTS OF OPTICAL PROPERTIES OF MINERALS.

COMPLETENESS AND ACCURACY OF THE DATA.

Out of about 950 species included in the tables suitable data were available for only about 400 species, and the author found it necessary to measure some or all of the optical constants of over 500 species. With these new measurements fairly satisfactory optic constants are available for all the minerals in the tables except armangite, atopite (Norway), boothite, cappelenite, carminite, catoptrite, georgiadesite, hellendite, hieratite, jeremejevite, manandonite, monimolite, morinite, nordenskioeldine, palmerite, phoenochroite, rhagite, rivaite, uhligite, and vrbaite, specimens of which the author was unable to find, and the unstable minerals dolerophanite, erythrosiderite, hydrocyanite, ilesite, kremersite, mallardite, molysite, oldhamite, and scacchite. It is hoped that data for these will soon be available and that hereafter descriptions of new minerals will include the optical constants; indeed, no mineral description is adequate without them.

With few exceptions the measurements were made by the methods described in the preceding chapter. The probable maximum limits of error are stated, but in some minerals the error may be considerably greater, for not all the measurements have been made twice. In many minerals the optical orientation in particular is only approximate and incomplete, for faceted crystals were rarely available. The powdered fragments were observed under the microscope for cleavage, elongation, or other easily recognized crystal direction, and the optical orientation was determined with relation to these features.

The greatest difficulty in procuring the data has been to get correctly labeled specimens, and much labor has been expended in getting consistent results. If type material had been available for all the minerals the results would be much more valuable and much labor would have been saved. So many errors in labeling specimens have been discovered that possibly a few of these errors have escaped detection. However, where there was any doubt as to the identification of the species a number of specimens were examined and on a few of the species, where sufficient material was available, simple chemical tests were made. The species that caused the most difficulty in these respects were the amorphous and microcrystalline minerals—the so-called colloids and metacolloids—and a few groups like the chlorites, the ferric sulphates, and the secondary uranium minerals. The data on some of these species will not be entirely satisfactory until the chemical analyses and optical measurements are made from identical material.

The measurements have brought out a number of valuable incidental results, among which are the following:

Priceite is a distinct species.

There is a remarkable series of amorphous hydrous oxides of antimony and some crystalline varieties that need much more study.

Mazapilite is identical with arseniosiderite.

Both forms of PbO—massicot and litharge—exist in nature.

A number of the colloidal minerals are variable and are hardly entitled to be called species.

Some of the metalloidal minerals may not be homogeneous. Chemical analyses of such material without careful microscopic examination are well-nigh useless.

Liebigite is probably identical with uranothallite.

Partschinite is probably identical with spessartite.

Much allanite is made up of a perceptibly isotropic form and a strongly birefracting form that is derived from the isotropic form.

The material commonly identified as scorodite is highly variable and needs further study.

Bementite and caryopilite are identical.

THE NEW DATA.

In the following pages of new data the species are arranged in alphabetical order, except where it was desired to show relations, and to these minerals cross references are given. The data are presented as briefly as possible, and discussions and references to the literature are avoided as far as practicable.

Under each mineral description the locality is named first, and the source of the specimen is placed next in parenthesis. The description of the hand specimen follows, if it is deemed essential, and after that the optical properties are given as determined on the powder. The greater part of the material was obtained from the following collections:

	Abbreviation.
Col. Washington A. Roebling	Col. Roebling.
United States National Museum	U. S. N. M.
American Museum of Natural History	A. M. N. H.
University of California	U. of C.
Yale University	Yale.
Harvard University	Harvard.
California State Mining Bureau	Cal. Min.
Princeton University	Princeton.
Johns Hopkins University	J. H. U.
Mr. F. A. Canfield, Dover, N. J.	

Mr. Frank L. Hess, Washington. D. C.	
Dr. W. T. Schaller, Washington, D. C.	
Mr. R. M. Wilke, Palo Alto, Calif.	
Field Museum of Natural History	F. M. N. H. Chicago.
University of Stockholm	U. of Stockholm.
National Museum of Natural History, Stockholm	N. M. N. H. Stockholm.

ACMITE.

Kongsberg, Norway (U. S. N. M. 16568). Optically –, 2V = 66° ± 5° (indices).

$\alpha = 1.765 \pm 0.003$. $\beta = 1.803 \pm 0.003$. $\gamma = 1.820 \pm 0.003$.

These data are near those of Wülfing for aegirite from Langesund:

$\alpha = 1.7630$ $\beta = 1.7990$ $\gamma = 1.8126$

ADAMITE.

Laurium, Greece (U. S. N. M. 50164). Nearly colorless, drusy crystals. Optically –, 2V = 87° ± 5° (indices).

$\rho > v$ (strong). Z is parallel to the elongation of the fragments.

$\alpha = 1.708 \pm 0.003$. $\beta = 1.734 \pm 0.003$. $\gamma = 1.758 \pm 0.003$.

It may be in part optically + and $\rho < v$ (strong), as reported.

ADELITE.

1. Jacobsberg, Sweden (N. M. N. H. Stockholm). Yellow or brown, greasy aggregates. Optically +, 2V nearly 90°, $\rho < v$ (perceptible). No cleavage noticed.

$\alpha = 1.712 \pm 0.003$. $\beta = 1.721 \pm 0.003$. $\gamma = 1.731 \pm 0.003$.

2. Jacobsberg, Sweden (A. M. N. H.). Probably not adelite. Brownish grains embedded in a large amount of hedaphane. The brownish grains have the following optical properties: Optically +, 2V = 61° ± 5° (indices), $\rho < v$ (rather strong).

$\alpha = 1.682 \pm 0.003$. $\beta = 1.695 \pm 0.003$. $\gamma = 1.735 \pm 0.003$.

AENIGMATITE.

See Enigmatite.

AESCHYNITE.

See Eschynite.

AGRICOLITE.

1. Johanngeorgenstadt, Saxony (Harvard). Lemon-yellow, coarsely radiating crystals. 2V large (?). Optically +, birefringence very low.

$\beta = 1.99 \pm 0.01$.

There is also a finely fibrous mineral, probably an alteration product of the agricolite.

2. Schwarzenberg, Saxony (A. M. N. H.). A finely fibrous mineral with moderate birefringence.

$$\beta = 2.03 \pm 0.01.$$

Probably an alteration product.

ALABANDITE.

La Sheeha, Puebla, Mexico (U. S. N. M.). Translucent and isotropic.

$$n_{Li} = 2.70 \pm 0.02.$$

ALLACTITE.

Nordmark, Sweden (A. M. N. H.). Optically −, 2V very small, $\rho > v$ (very strong).

$\alpha = 1.761 \pm 0.003.$ $\beta = 1,786 \pm 0.003.$ $\gamma = 1.787 \pm 0.003.$

Colorless in powder.

ALLANITE.

1. Crest of Blue Ridge, 9 miles south of Roanoke, Va. (Prof. T. L. Watson). A microscopic study of the black vitreous allanite, apparently from the freshest part of the specimen, showed that it is made up of two different minerals, a pale olive-green, sensibly isotropic mineral and a pale-green birefracting mineral. The birefracting mineral is derived from the sensibly isotropic mineral and replaces it along streaks and irregularly.

The isotropic mineral has an index of refraction of about 1.697 ± 0.003.

The birefracting mineral is faintly pleochroic; X = pale green and Z = yellowish. The mean index of refraction is about 1.71 and the birefringence is about 0.01.

2. Amherst County, Va. (F. L. Hess). All the material examined is birefracting. It is probably optically negative, with a large axial angle, but no good interference figure was obtained, probably owing to some abnormal dispersion.

$$\beta = 1.755 \pm 0.01.$$

Birefringence = 0.01 approximately. Pleochroic; X = pale yellowish and Z = deep reddish brown.

3. Albany, Wyo. (F. L. Hess). The blackish-brown vitreous material is made up of two or probably three distinct minerals. Thin sections show the relations clearly. A nearly colorless, iso-

tropic mineral is replaced in irregular areas by a pale-greenish, faintly birefracting mineral, and these two minerals are in turn altered along the borders of the grains and along cracks and streaks to a reddish-brown, rather strongly birefracting mineral, which makes up more than half the sections of the large piece and all but a small core of the small grains, some of which are as much as several millimeters across. The alterations suggest the alteration of olivine to iddingsite, and in both the oxidation of iron is probably an important change.

a. The colorless to pale-greenish isotropic mineral has a rather constant index of refraction of 1.685 ± 0.005.

b. The pale-green birefracting mineral has a somewhat higher index of refraction and a weak birefringence. It is pleochroic; X = nearly colorless and Z = pale green.

c. The reddish-brown mineral has the following optical properties, which vary a little:

Optically $-$, 2V = rather large, $\rho > \upsilon$ (rather strong).

$\alpha = 1.727 \pm 0.005$.	X = pale yellowish.
$\beta = 1.739 \pm 0.005$.	Y = reddish brown.
$\gamma = 1.751 \pm 0.005$.	Z = reddish brown.

4. Llano County, Tex. (U. S. N. M. 84416). In mass, black and vitreous; in thin section rather deep olive-green. Isotropic and nearly homogeneous.

$$n = 1.725 \pm 0.005.$$

5. Garto, Arendal, Norway (U. S. N. M. 49022). Pale olive-green in section and perceptibly isotropic for the fresh vitreous center of the specimen.

$$n = 1.670 \pm 0.005; \text{ varies somewhat.}$$

Much of this specimen is a brownish vitreous alteration product. It is red-brown in section and different grains differ greatly in optical properties. Part is isotropic and part is birefracting. The index of refraction differs greatly but in much of the material it is near $1.60 \pm$.

Evidently the "allanite" of all these specimens is made up of at least two and probably three distinct minerals. One of them is pale, sensibly isotropic, and has an index of refraction of about 1.68 to 1.70; another, possibly related to the one just mentioned, has a somewhat higher index of refraction, a weak birefringence, and is pleochroic in green and yellow; the third is clearly derived from the others and has the following optical properties:

Optically $-$, 2V = rather large, $\rho > \upsilon$ (rather strong).

$$\beta = 1.71 \text{ to } 1.76.$$

Birefringence 0.01 to 0.02. Pleochroic in red-brown, with absorption Y and Z>X.

ALUMIAN.

Sierra Almagrera, Spain (A. M. N. H.). Minute rhombs that have striated sides, resembling somewhat the hopper-shaped cubes of halite, but they are probably striated rather than skeleton crystals. They show extinction in segments somewhat like hour-glass structure. When turned on edge they give a good interference figure and are uniaxial+.

$$\omega=1.583\pm0.003. \qquad \epsilon=1.602\pm0.003.$$

ALUMINITE.

1. Newhaven, Sussex, England (U. S. N. M. 9290). White porcelain-like. Under the microscope it is seen to occur in rather coarse fibers which have negative elongation and perceptibly parallel extinction. 2V very near. 90°.

$$\alpha=1.459\pm0.003. \qquad \beta=1.464\pm0.003. \qquad \gamma=1.470\pm0.003.$$

2. Near Denver & Rio Grande Railroad at crossing of Green River, Utah (H. S. Gale). A white, chalky nodule. The main part is nearly pure aluminite, but the surface is largely composed of another mineral, probably a dehydration product of the aluminite.

The aluminite occurs in minute prisms which have perceptibly parallel extinction and X parallel to the elongation. Optically+, 2V large.

$$\alpha=1.460\pm0.003. \qquad \gamma=1.470\pm0.003.$$

The dehydration product occurs also in prisms, probably after the aluminite. It shows large extinction angles, is optically+, and has a large axial angle. An optic axis emerges nearly normal to the prisms.

$$\beta=1.500\pm0.003.$$

Birefringence 0.01.

3. Saxony, Germany (U. S. N. M. 16793). Earthy white mass. Very finely fibrous, probably optically+.

$$\beta=1.52\pm0.01.$$

Birefringence about 0.02.

Not very satisfactory and rather doubtful; may be the alteration product of specimen 2.

ALUNOGEN.

1. South Bolivia (U. of C.). White fibers that have a large extinction angle. Optically+.

$$\alpha=1.475\pm0.003. \qquad \beta=1.478\pm0.003. \qquad \gamma=1.485\pm0.003.$$

2. Utah (U. S. N. M. 47550). White fibers with extinction angles from 0 to very large. Angle of Z to elongation large. Optically +, 2V small.

$\alpha = 1.473 \pm 0.003$. $\beta = 1.474 \pm 0.003$. $\gamma = 1.480 \pm 0.003$.

Probably monoclinic.

ALURGITE.

Piedmont, Italy (W. T. Schaller). Copper-red mica. Optically −, 2V near 0, $\rho > v$ (slight).

$\beta = 1.594 \pm 0.003$.

Birefringence near that of muscovite. In thin flakes; pale pinkish; pleochroism very faint.

AMARANTITE.

Caracoles, Chile (U. S. N. M. 82631). Minute fibers. Optically −, 2V = 28° ± 5° (indices), pleochroic with absorption $Z > Y > > X$.

$\alpha = 1.51 \pm 0.01$; nearly colorless. $\beta = 1.605 \pm 0.003$; pale orange-yellow. $\gamma = 1.611 \pm 0.003$; orange-yellow.

AMPANGABÉITE.

Ampangabé, Madagascar (Col. Roebling).
In section red-brown and isotropic. Fracture conchoidal.

$n = 2.13 \pm 0.03$.

ANAPAITE.

Anapa, Russia. Soft, glassy, greenish-white crystals. Optically +, 2E = 94° ± 3° (measured), 2V = 54° ± 2°, $\rho > v$ (perceptible).

$\alpha = 1.602 \pm 0.003$. $\beta = 1.613 \pm 0.003$. $\gamma = 1.649 \pm 0.003$.

Some plates are nearly normal to Z. Sachs[21] states that the mineral is optically −. 2H = 127° ($n = 1.5753$) $\rho < v$ (rather strong). He apparently measured $2H_o = 127$, $2V_o = 121$, $2V_a = 59$, and the mineral would be optically + and $\rho > v$.

ANCYLITE.

Narsarsuk, Greenland (U. S. N. M. 84875). Brown crystals. Pale green in section. Optically +, nearly or quite uniaxial.

$\omega = 1.865$, somewhat variable.

Birefringence about 0.04.

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[21] Sachs, A., Akad. Wiss. Berlin Sitzungsber., 1902, p. 18.

ANDRADITE.

Arizona (analyzed by W. T. Schaller). Empire mine, Nogales quadrangle, Ariz. The analysis[22] gives SiO_2, 37.16; Al_2O_3, 3.47; Fe_2O_8, 28.11; CaO, 30.23; MgO, 0.51; FeO, none; MnO, present.

$n = 1.890 \pm 0.005$ (varies 0.01).

ANKERITE.

1. Antwerp, N. Y. (U. S. N. M. 44870). Light-brownish rhombs. Not homogeneous. Uniaxial −.

ω ranges from less than 1.73 to greater than 1.83. The greater part has ω about 1.83.

2. Chester County, Pa. (U. S. N. M. 3965). Nearly colorless cleavage pieces. Uniaxial −.

ω ranges from 1.705 to 1.715.

Birefringence as in calcite.

ANNABERGITE.

Lovelocks, Nev. (U. of C.). Tabular crystals with elongated, rhombic outline (fig. 6). The angle between the edges is 55° ± 1°. The crystals are zoned. The main part of the crystals has the following optical properties: Optically −, $2V = 82° \pm 3°$ (indices), $\rho > v$ (rather strong). Nearly colorless in section. X is sensibly normal to the tablets, Y is in the acute angle of the rhombs and makes an angle of $35\frac{1}{2}° \pm \frac{1}{2}°$ with the longer edge. There appears to be a perfect cleavage parallel to the flat face and possibly to the two other faces.

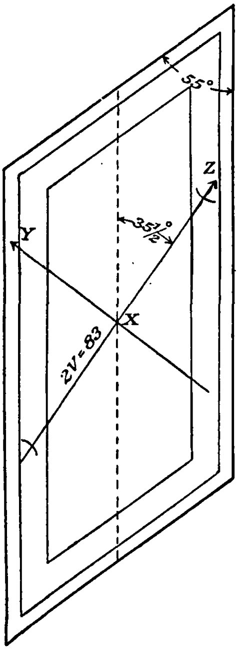

FIGURE 6.—Optical orientation and zonal growths of annabergite on tabular face {010}.

$\omega = 1.622 \pm 0.003$. $\beta = 1.658 \pm 0.003$.
$\gamma = 1.687 \pm 0.003$.

A narrow outer zone has a considerably lower index of refraction and a larger extinction angle. It probably contains magnesium and is related to cabrerite.

Annabergite must be monoclinic, and $X = b$, $Z \wedge c = 35\frac{1}{2}°$ in acute angle β (variable).

ANTLERITE.

Arizona (original material, U. S. N. M.). Optically +, $2E_{Na} = 62° \pm 5°$ (measured), $2V_{Na} = 35° \pm 3°$, $\rho < v$ (very strong). Y = the

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[22] U. S. Geol. Survey Bull. 582, p. 83, 1915.

elongation; the plane of the optic axis is normal to the fibers, pleochroism is strong, absorption $Y \geqq Z > X$.

$\alpha = 1.730 \pm 0.003$; pale yellow-green (31*f*).[23] $\beta = 1.737 \pm 0.003$; viridine green (33*d*).[23] $\gamma = 1.785 \pm 0.003$; viridine green (33*e*).[23]

APHROSIDERITE.

1. Weilburg, Prussia (Yale, B. Coll. 3904). Chiefly minute fibers with some hexagonal plates. These plates are perceptibly isotropic.

α and $\beta = 1.612 \pm 0.003$; olive-green. $\gamma = 1.616 \pm 0.003$; colorless.

The plates gave no satisfactory interference figure, but they are evidently optically + and have a small axial angle.

2. Nassau (A. M. N. H.). Plates and fibers. Optically −, 2V = small. Tend to be on a face normal to Bx_a.

$$\alpha = 1.58 \pm 0.01, \qquad \gamma = 1.60 \pm 0.01.$$

The properties are variable and the mineral doubtful.

3. British Columbia. Very finely crystalline.

$$\beta = 1.623 \pm 0.003.$$

Birefringence low.

APJOHNITE.

"Bushmanite," Baschjesman Rio, South Africa (Col. Roebling). Soft, white, silky fibers. Optically −, 2V small. Sections normal to the plane of the optic axis show parallel extinction, sections parallel to that plane show large extinction angles, $Z \wedge$ elongation about 29°. Fibers tend to lie on (010) and to a less extent on (100). Monoclinic; $Y = b$ and $Z \wedge c = 29 \pm$.

$$\alpha = 1.478 \pm 0.003. \qquad \beta = 1.482 \pm 0.003. \qquad \gamma = 1.482 \pm 0.003.$$

ARIZONITE.

Near Hackberry, Ariz. Original material (U. S. N. M.). Nearly opaque.

$$n_{Li} = 2.62 \text{ nearly.}$$

Birefringence moderate (?).

ARSENIOPLEITE.

Sjö mine, Grythytte parish, Sweden (U. S. N. M. 85101). Optically +, 2V small but distinctly biaxial.

Color in transmitted light apricot-orange (11′−), nonpleochroic.

$$\omega = 1.794 \pm 0.003. \qquad \epsilon = 1.803 \pm 0.003.$$

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[23] Ridgway, Robert, Color standards and nomenclature, 1912.

ARSENIOSIDERITE.

1. Romanêche, France (U. S. N. M. 84358). Coating of yellow-brown fibers. Uniaxial −. Rather strongly pleochroic in brownish red with absorption $\omega > \epsilon$.

In fibers with the flat face (001) and the optic axis normal to this face and the fibers.

$\omega = 1.870 \pm 0.005$. $\epsilon = 1.792 \pm 0.005$.

It may be orthorhombic with a very small axial angle or tetragonal.

2. Jesus Maria mine, Mazapila, Mexico (U. S. N. M. 85174). "Mazapilite." Uniaxial −; strongly pleochroic.

$\omega = 1.898 \pm 0.005$, dark reddish brown. $\epsilon = 1.815 \pm 0.005$, nearly colorless.

ARTINITE.

Val Laterna (U. S. N. M.). White fibers. Optically −, $2V = 71°$ (indices). Y = fibers. The fibers tend to lie on a face nearly normal to an optic axis.

$\alpha = 1.489 \pm 0.003$. $\beta = 1.534 \pm 0.003$. $\gamma = 1.557 \pm 0.003$.

ASCHARITE.

Schmidtmannshall, Prussia (Col. Roebling). Very minute, matted fibers, X = elongation.

$\alpha = 1.53$ $\beta = 1.55$ $\gamma = 1.55$

All three values somewhat variable.

Evidently optically − with small 2V.

ASTROLITE.

Neumark, Germany (A. M. N. H.). Plates and fibers. Optically −, 2V small, $\rho > v$ (perceptible). X is normal to the plates.

$\alpha = 1.570 \pm 0.003$. $\beta = 1.594 \pm 0.003$. $\gamma = 1.597 \pm 0.003$.

ATELESTITE.

Schneeberg, Saxony (Col. Roebling). Optically +, $2E_{Na} = 107°$, $2V_{Na} = 44° \pm 2°$ (measured), $\rho < v$ (rather strong).

$\alpha = 2.14 \pm 0.01$. $\beta = 2.15 \pm 0.01$. $\gamma = 2.18 \pm 0.01$.

AUERLITE.

Henderson County, N. C. (U. S. N. M. 4914a). Uniaxial +.

$\beta = 1.65 \pm 0.01$.

Birefringence 0.01.

AURICHALCITE.

1. Leadville, Colo. Optically −, 2V small. The plane of the optic axes is parallel to the cleavage (100), and Z is parallel to the elongation.

$\alpha = 1.655 \pm 0.003$. $\gamma = 1.745 \pm 0.003$.

2. Yankee mine, Tintic, Utah (U. S. N. M. 87824). Nearly colorless plates. Optically −, 2V very small, $\rho < v$ (strong). Faintly pleochroic in very pale green with absorption. Z and Y > X. Y is nearly normal to the plates, and Z is parallel to the elongation.

$\alpha = 1.654 \pm 0.003$. $\beta = 1.740 \pm 0.005$. $\gamma = 1.743 \pm 0.003$.

AZURITE.

1. Broken Hill, Australia. Optically +, 2V moderately large, $\rho > v$ (rather strong). Pleochroic in blue with absorption Z > > Y > X.

$\alpha = 1.730 \pm 0.005$. $\beta = 1.754 \pm 0.005$. $\gamma = 1.836 \pm 0.005$.

2. Rochester mining district, Nev. Characters similar to those of No. 1. Z normal to cleavage or platy structure.

$\alpha = 1.730 \pm 0.005$. $\beta = 1.755 \pm 0.005$. $\gamma = 1.835 \pm 0.005$.

BABINGTONITE.

1. Arendal, Norway (U. S. N. M. 47035). Optically +. Dispersion strong $\rho > v$, 2V medium large, dispersion of bisectrices strong.

$\alpha = 1.713 \pm 0.003$; deep green. $\beta = 1.725 \pm 0.003$; pale brown.
$\gamma = 1.746 \pm 0.003$; rather pale brown.

2. Baveno, Italy.

$\alpha = 1.713 \pm 0.003$. $\beta = 1.727 \pm 0.003$. $\gamma = 1.746 \pm 0.003$.

Otherwise similar to specimen 1.

BADDELEYITE.

Minas Geraes, Brazil (U. S. N. M. 86106). Brown grains. Colorless in powder. Optically −, $2E = 70$, $2V = 30 \pm 1°$ (measured), $\rho > v$ (rather strong). Polysynthetic twinning is common.

$\alpha = 2.13 \pm 0.01$. $\beta = 2.19 \pm 0.01$. $\gamma = 2.20 \pm 0.01$.

BAKERITE.

Death Valley, Calif. (Harvard). Very fine crystalline aggregates.

$n = 1.583 \pm 0.005$.

Birefringence $= 0.02 \pm$. Compare with Howlite (p. 87).

BARRANDITE.

1. Near Pribram, Bohemia (U. S. N. M. 84615).

Spheroidal concretions. Fibrous. Optically +, 2V large, $\rho > v$ (strong).

$$\beta = 1.65 \pm 0.03.$$

Birefringence = 0.03 ±.

2. Cerhovic, Bohemia (U. S. N. M. 84343). Pale-yellow crusts. Moderately coarse fibers. Optically +, 2V rather large, $\rho > v$ (rather strong).

$\alpha = 1.535 \pm 0.003.$ $\beta = 1.541 \pm 0.003.$ $\gamma = 1.554 \pm 0.003.$

Probably not barrandite.

BARTHITE.

Guchab, Otavi, German Southwest Africa (Col. Roebling). Grass-green drusy crystals. The microscope shows that they are made up of successive zones. The center and somewhat larger part is very pale green. A rather sharply separated outer shell is much darker and is yellowish green.

A. The pale-green core is optically +, 2V = moderate, $\rho > v$ (slight to moderate).

$\alpha = 1.770 \pm 0.003.$ $\gamma = 1.783 \pm 0.003.$

B. The darker, outer zone is slightly pleochroic, optically +, 2V = near 90°, $\rho < v$ (moderate).

$\alpha = 1.780 \pm 0.005.$ $\beta = 1.795 \pm 0.005.$ $\gamma = 1.815 \pm 0.005.$

BARYSILITE.

Harstig mine, Pajsberg, Sweden (U. S. N. M. 62747). Uniaxial −.

$\omega = 2.07 \pm 0.01.$ $\epsilon = 2.05 \pm 0.01.$

BASTNAESITE.

West Cheyenne Canyon, El Paso County, Colo. (U. S. N. M. 81857). Uniaxial +. Nearly colorless in section.

$\omega = 1.717 \pm 0.003.$ $\epsilon = 1.818 \pm 0.003.$

BAVENITE.

Baveno, Italy (U. S. N. M. 85180). Clear, tabular crystals. Optically +, 2V small, tablets {100} are nearly normal to X, and Y is parallel to the elongation. Tablets turned on edge show twinning {100} and very small extinction angles.

$\alpha = 1.578 \pm 0.003.$ $\beta = 1.579 \pm 0.003.$ $\gamma = 1.583 \pm 0.003.$

BAYLDONITE.

Near St. Day, Cornwall, England (Col. Roebling). Interwoven fibers too fine for accurate measurements. Optically+, 2V large, $\rho < v$ (strong?). Sections with weak birefringence show nearly parallel extinction with Z′ parallel to the elongation; sections that have strong birefringence show the angle of Y to the elongation about 45°. Hence probably monoclinic, with $X = b$ and $Y \wedge c = 45° \pm$.

$\alpha = 1.95 \pm 0.01$. $\gamma = 1.99 \pm 0.01$.

BEAVERITE.

Horn Silver mine, near Frisco, Beaver County, Utah. Type material (U. S. N. M. 86986). Very finely crystalline. Consists in part of minute hexagonal plates. Optically−.

$\omega = 1.83$ to 1.87. Average about 1.85.

Birefringence strong.

BECHILITE.

Bechilite is a doubtful species. The following data are derived from specimens labeled bechilite.

1. Larderello, Italy. Made up chiefly of sassolite and larderellite.

2. Larderello, Italy (A. M. N. H.). Optically+, $2V = 62° \pm 5°$ (indices). Dispersion slight.

$\alpha = 1.470 \pm 0.003$. $\beta = 1.488 \pm 0.003$. $\gamma = 1.542 \pm 0.003$.

3. Tarapacá, Chile (J. H. U.). Borocalcite (hayesine). The specimen is no doubt ulexite.

4. See Boussingaultite No. 1 (p. 50).

5. Baños del Toro, Chile (Phillips). Hayesine. Consists partly of minute fibers, in which the angle of Y to the elongation is about 20° and X is normal to the fibers. $\beta = 1.509$. Birefringence $= 0.01 \pm$. No doubt ulexite. Also a mineral, uniaxial−.

$\omega = 1.531 \pm 0.003$. $\epsilon = 1.510 \pm 0.003$.

BELLITE.

Magnet mine, Tasmania (Col. Roebling). Reddish needles. Nearly colorless in section. Uniaxial−. In thick sections faintly pleochroic in pale pink. Absorption $\omega > \epsilon$.

$\omega = 2.16 \pm 0.01$. $\epsilon = 2.14 \pm 0.01$.

Probably hexagonal prisms striated parallel to the base and with the base.

BEMENTITE.

1. Trotter mine, Franklin Furnace, N. J. (U. S. N. M. 47684). Colorless shreds and fibers. Optically −, 2V nearly or quite 0. X is perceptibly normal to the plates. Resembles sericite.

$\alpha = 1.624 \pm 0.003$. β and $\gamma = 1.650 \pm 0.003$.

2. Pajsberg, Sweden (A. M. N. H.). Caryopilite. Perceptibly uniaxial, optically −. Weakly pleochroic in brown, absorption $Z > X$. The mineral is fibrous and X is normal to the fibers.

$\alpha = 1.602 \pm 0.003$. $\beta = 1.632 \pm 0.003$. $\gamma = 1.632 \pm 0.003$.

3. Harstig mine, Pajsberg, Sweden (U. S. N. M. 85170). Caryopilite. Perceptibly uniaxial (or 2V nearly 0). Optically −, fibers tend to lie on a face nearly normal to X.

$\alpha = 1.603 \pm 0.003$. $\beta = 1.632 \pm 0.003$. $\gamma = 1.632 \pm 0.003$.

The chemical composition, habit, and optical properties of bementite and caryopilite are so much alike as to leave little doubt of their identity. The name bementite has the priority.

BERAUNITE.

Giessen, Germany (U. S. N. M. 80622). Variety eleonorite. Optically +, 2V medium large, $\rho > v$ (very marked). X emerges from the cleavage. $Z = b$, $Y \wedge c = 1.5°$. Pleochroic.

$\alpha = 1.775 \pm 0.003$; pale flesh color (7′ f) to colorless.
$\beta = 1.786 \pm 0.003$; pale flesh color (7′ f) to colorless.
$\gamma = 1.815 \pm 0.003$; carnelian red (7′ −) to vinaceous (7′ i).[24]

BERZELIITE.

Långban, Sweden (U. S. N. M. 48976). Isotropic, clear, and glassy.

$n = 1.727 \pm 0.003$.

BETAFITE.

1. Antaifasy, Madagascar (U. S. Geol. Survey; from Prof. Lacroix). Crystals showing nearly black, glassy center and dull gray, altered outer zones. In section nearly colorless isotropic grains.

$n = 1.915 \pm 0.02$.

2. Betafo, Madagascar (U. S. N. M.). Similar to No. 1.

$n = 1.925 \pm 0.01$.

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[24] Ridgway, Robert, Color standards and nomenclature, 1912.

BEUDANTITE.

Dernbach, Hessen-Nassau, Germany (U. S. N. M. 84613). Optically –, 2V medium, abnormal dispersion. Nearly colorless in section.

$$\beta = 1.96 \pm 0.01.$$

The birefringence is low and gives abnormal green interference colors. The basal hexagonal section is divided into hexagonal segments, and these show polysynthetic twin lamellae parallel to the hexagonal edge. The mineral alters to a brown mineral that has a higher index of refraction, first becoming strongly pleochroic with X′ dark brown, and Z′ nearly colorless.

BIEBERITE.

1. Artificial bieberite, crystallized from a solution of cobalt sulphate at 23° C. Carmine-colored tabular crystals. Optically –; 2V near 90°; dispersion slight.

$$\alpha = 1.477 \pm 0.003. \qquad \beta = 1.483 \pm 0.003. \qquad \gamma = 1.489 \pm 0.003.$$

2. Natural bieberite from Bieber, Hesse; had altered to the pentahydrate corresponding to chalcanthite.

BINDHEIMITE.

1. Fresno County, Calif. (U. of C.). Green, opal-like. In large part isotropic.

$$n = 1.84 \pm 0.02.$$

The specimen contains a considerable amount of an unknown mineral which probably represents a partial crystallization of the bindheimite and has the following properties:

Uniaxial –, colorless in section. Perfect cleavage parallel to the optic axis.

$$\omega = 2.08 \pm 0.01. \qquad \epsilon = 1.82 \pm 0.01.$$

2. Fresno County, Calif. (U. of C.). Similar to specimen No. 1 but has a duller luster.

$$n \text{ of isotropic part} = 1.85 \pm 0.02.$$

3. Fresno County, Calif. (U. of C.). Brown, opal-like. Isotropic.

$$n = 1.87 \pm 0.01.$$

4. Locality unknown. Chiefly cryptocrystalline.

$$n = 2.0 \text{ approximately}.$$

Birefringence strong.

5. Eureka district, Nev. (Cal. Min.). Chiefly isotropic.

$$n=1.87\pm0.01.$$

Contains also the crystalline mineral of specimen No. 1.

BISBEEITE.

Bisbee, Ariz. (original material, W. T. Schaller). Nearly white, cotton-like. Very thin tablets normal to X and with Z parallel to the elongation. Optically +, 2V small, pleochroic.

$\alpha=1.615\pm0.01$; nearly colorless. $\beta=1.625\pm0.01$; nearly colorless. $\gamma=1.71\pm0.01$; pale greenish.

BISMITE.

1. Schneeberg, Saxony (U. of C. No. 597). Canary-yellow powder made up of minute fibers and shreds.

$$\alpha=1.82\pm0.02. \qquad \gamma=2.00\pm0.02.$$

The highest index of all the fibers is about 2.00, and the mineral is optically – with a small axial angle.

2. Johanngeorgenstadt, Saxony (U. of C.). Canary-yellow coating. Uniaxial –, basal plates.

$$\omega=2.01\pm0.01. \qquad \epsilon=1.83\pm0.01.$$

BISMUTITE.

1. Las Animas, Colo. (U. S. N. M. 9742). Amorphous-looking mass. Indistinctly polarizing.

$$n=2.25\pm0.03.$$

Birefringence moderate to strong.

2. Cornwall, England (U. of C.). Indefinite material, labeled "bismite." Partly birefracting, with rather strong birefringence.

$$n=2.28\pm0.03.$$

3. Lone Pine, Inyo County, Calif. (U. of C.). Fibrous to cryptocrystalline after the manner of serpentine. Not entirely homogeneous, but the following are the properties of the chief part. Optically –, 2E rather large.

$$\beta=2.17 \text{ approximately.}$$

Birefringence estimated at 0.05. Properties somewhat variable.

4. Pala, Calif. (W. T. Schaller). Identified by qualitative chemical tests. Nearly colorless, amorphous in appearance. In section it is

made up of matted fibers with Z parallel to the elongation and moderately strong birefringence (estimated at 0.05).

β is variable but chiefly about 2.15.

Optically + (?) with a medium to small axial angle. Probably a crystallized or partly crystallized gel.

5. No locality (Cal. Min.). Light-yellowish. Very finely crystalline. Birefringence moderate.

$n = 2.16 \pm 0.02$, probably a crystallized gel.

Bismutite is probably in part amorphous but chiefly a crystallized gel. It is probably not entirely homogeneous nor uniform.

BISMUTOSPHAERITE.

Schneeberg, Saxony (U. S. N. M. 85110). Very thin plates normal to the optic axis. Uniaxial −.

$\omega = 2.13 \pm 0.01$. $\epsilon = 1.94 \pm 0.01$.

BOBIERRITE.

Mexillones, Chile (Col. Roebling). Needles that tend to lie on face (010), which is normal to Y; angle of Z to elongation 29°. Optically +, $2E = 125° \pm 5°$, $2V = 71° \pm 3°$ (measured), $\rho < v$ (perceptible).

$\alpha = 1.510 \pm 0.003$. $\beta = 1.520 \pm 0.003$. $\gamma = 1.543 \pm 0.003$.

BOLÉITE.

1. Boléo, Baja California (U. S. N. M. 80943). Uniaxial −. Bluish green in section and nonpleochroic.

$\omega = 2.05 \pm 0.02$. $\epsilon = 2.03 \pm 0.02$.

Not entirely homogeneous, ω in part as low as 2.04, in part considerably greater than 2.05.

2. See Percylite (p. 118).

BORICKITE.

1. Leoben, Styria (J. H. U. 653). Reddish-brown opaline material. In large part isotropic and reddish brown in section. n ranges from about 1.57 to about 1.67.

The darker part has the higher index of refraction, and some fibers show strong birefringence.

This material is highly variable and amorphous.

BOUSSINGAULTITE.

1. Artificial boussingaultite. Crystallized from a solution of $(NH_4)_2SO_4$ and $MgSO_4$ in molecular proportion by allowing the solution to stand in a desiccator at 21° C. The supersaturated solution was shaken, and the crystals that formed were studied. Optically +, $2E = 77° \pm 1°$, $2V = 50° \pm 1°$ (measured), $\rho > \upsilon$ (perceptible).

$\alpha = 1.469 \pm 0.003$. $\beta = 1.470 \pm 0.003$. $\gamma = 1.479 \pm 0.003$.

These data agree with the data formerly given. After the saturated solution had stood in a desiccator for two days a second crop of crystals appeared. These crystals were stout tablets, the largest of them a millimeter across and rudely hexagonal in outline with one pair of edges somewhat longer. Extinction is nearly parallel to this longer edge, and Bx_a (Z) emerges at an angle of about 35° to the normal to the tablets and in the direction of the long edge. If this face is {110}, the data agree with those formerly given and $Y = b$, $X \wedge c$ small.

2. Larderello, Tuscany (Col. Roebling). Optically +, $2V = 55° \pm 5°$ (indices).

$\alpha = 1.473 \pm 0.003$. $\beta = 1.486 \pm 0.003$. $\gamma = 1.539 \pm 0.003$.

These data do not agree with the data formerly given, and the material is probably incorrectly labeled. Compare with Bechilite, No. 2 (p. 45). Contains considerable sassolite.

BRACKEBUSCHITE.

Cordoba, Argentina (A. M. N. H.). Optically +, 2V large, pleochroism very strong.

$\alpha_{Li} = 2.28 \pm 0.02$; nearly colorless. $\beta_{Li} = 2.36 \pm 0.02$; dark, clouded, reddish brown. $\gamma_{Li} = 2.48 \pm 0.02$; clear reddish brown.

BRANDISITE.

Fassathal (Col. Roebling). Green, chloritic mineral. Optically −, 2V very small, X normal to the cleavage, pleochroic.

$\alpha = 1.648 \pm 0.003$; pale orange-yellow. $\beta = 1.660 \pm 0.003$; pale green. $\gamma = 1.660 \pm 0.003$; pale green.

BRANDTITE.

Harstig mine, Pajsberg, Sweden (U. S. N. M. 49048). Optically +, $2E = 40° \pm 2°$, $2V = 23° \pm 1°$ (measured), $\rho < \upsilon$ (rather strong). X is nearly or quite normal to the perfect cleavage. Cleavage pieces show twinning normal to the cleavage and symmetrical extinction with Y′ to composition plane $= 6° \pm 1°$.

$\alpha = 1.709 \pm 0.003$. $\beta = 1.711 \pm 0.003$. $\gamma = 1.724 \pm 0.003$.

BRANNERITE.

Indian Bar, Idaho (type, F. L. Hess). In section isotropic and light reddish brown.

$n_{Li} = 2.26 \pm 0.02$ (varies a little). $n_{Na} = 2.30 \pm 0.02$.

BROCHANTITE.

Horn Silver mine, Frisco, Utah (U. S. N. M. 81120). Optically −, $2V = 70° \pm 5°$ (indices), $\rho < v$ (rather strong). Green in section and nonpleochroic.

$\alpha = 1.730 \pm 0.003$. $\beta = 1.778 \pm 0.003$. $\gamma = 1.803 \pm 0.003$.

BRUGNATELLITE.

1. Italy (Col. Roebling). Plates, uniaxial −.

$\omega = 1.535$.

Birefringence rather strong.

2. Mount Ramazzo, Italy (U. S. N. M.). Plates, uniaxial −.

$\omega = 1.540 \pm 0.003$. $\epsilon = 1.510 \pm 0.005$.

CABRERITE.

Laurium, Greece (U. S. N. M. 86105). Optically −, 2V near 90°. X is normal to the cleavage, which is highly perfect. Pale green in section.

$\alpha = 1.62 \pm 0.01$. $\beta = 1.654 \pm 0.003$. $\gamma = 1.689 \pm 0.003$.

Compare with Annabergite (p. 40).

CACOXENITE.

1. Vogtland, Saxony (U. S. N. M. 3923). Yellowish fibers. Uniaxial +, slender prismatic crystals, pleochroic.

$\omega = 1.580 \pm 0.003$; pale yellow. $\epsilon = 1.643 \pm 0.003$; canary-yellow.

Parts of some of the fibers, especially near the ends, have considerably higher indices of refraction.

2. Trenic, Bohemia (Cal. Min.). Radiating fibers. Uniaxial +, minute fibers, pleochroic.

$\omega = 1.580 \pm 0.003$; pale yellow. $\epsilon = 1.640 \pm 0.003$; darker yellow.

3. Tonopah, Nev. (U. of C.). Uniaxial+, delicate needles, pleochroic.

$\omega = 1.585 \pm 0.003$; pale yellowish. $\epsilon = 1.656 \pm 0.003$; orange-yellow.

CALCIOFERRITE.

1. Battenberg, Bavaria (A. M. N. H.). Pale-yellow powder on quartz. Perceptibly uniaxial−, optic axis normal to the plates.

$$\omega = 1.57 \text{ to } 1.58 \text{ (varies)}.$$

Birefringence low.

2. Battenberg, Bavaria (Col. Roebling). Uniaxial−.

$$\omega = 1.56.$$

Birefringence very low. In part it appears nearly isotropic and may be partly amorphous. It contains many shreds whose optical properties resemble sericite.

CALEDONITE.

Inyo County, Calif. (U. of C.). Optically−, 2V = 85° ± 5° (indices), $\rho < v$ (barely perceptible).

$\alpha = 1.818 \pm 0.003$. $\beta = 1.866 \pm 0.003$. $\gamma = 1.909 \pm 0.003$.

CARACOLITE.

Caracoles, Chile (A. M. N. H.). Water-clear, glistening crystals. Optically−, 2V very large, $\rho > v$ (rather strong). No perceptible cleavage.

$\alpha = 1.743 \pm 0.005$. $\beta = 1.754 \pm 0.005$. $\gamma = 1.764 \pm 0.005$.

Not entirely homogeneous. Some parts show polysynthetic twinning or similar structure with rather large extinction angle; others, after crushing, look like an aggregate of crystals, as if the material were an inversion or alteration product derived from the original crystal. The appearance may be due to complex twinning.

CARNOTITE.

Long Park, Montrose County, Colo. (F. L. Hess). Yellow powder. Optically−, 2E = 90° ± 5°, 2V = 43° ± 2° (measured), 2V = 40° ± 5° (indices). Minute tabular crystals normal to X with an angle of 78° ± 1° between the edges. Nearly or quite colorless in section.

$\alpha = 1.750 \pm 0.005$. $\beta = 1.925 \pm 0.005$. $\gamma = 1.950 \pm 0.005$.

CARPHOSIDERITE.

Greenland (Col. Roebling). Yellow, botryoidal crusts. Very fine interwoven fibers. Different layers have somewhat different optical properties. Elongation +, probably optically +.

$\alpha = 1.70 \pm 0.03$. $\gamma = 1.80 \pm 0.02$.

The material is very unsatisfactory. The optical data suggest the possibility that the mineral is jarosite.

CARYINITE.

Långban, Sweden (U. S. N. M. 82744). Optically +, $2E = 78° \pm 4°$, $2V = 41° \pm 3°$ variable (measured), $\rho > \upsilon$ (slight). Z nearly normal to cleavage.

$\alpha = 1.776 \pm 0.005$. $\beta = 1.780 \pm 0.005$. $\gamma = 1.805 \pm 0.005$.

The indices of refraction are somewhat variable (± 0.01). The values given are about the average.

CARYOCERITE.

Langesund, Norway (Brögger; U. of Stockholm). Isotropic, yellowish brown in section.

$n = 1.74 \pm 0.01$.

CARYOPILITE.

See Bementite (p. 46).

CASTANITE.

1. Chile (A. M. N. H.). Pale, reddish-brown, resinous mass. Optically +, $2E = 53°$, $2V = 34° \pm 2°$ (measured), $2V = 35°$ (indices), $\rho > \upsilon$ (rather strong); strongly pleochroic.

$\alpha = 1.527 \pm 0.003$; nearly colorless. $\beta = 1.532 \pm 0.003$; nearly colorless. $\gamma = 1.583 \pm 0.003$; rather strong orange-yellow or yellow-brown.

2. Sierra Capra, Chile (Col. Roebling). Hohmannite = castanite. Brown, vitreous crystals. Optically +, 2V rather small, $\rho > \upsilon$ (moderate). No cleavage noticed.

$\alpha = 1.524 \pm 0.003$; colorless. $\beta = 1.530 \pm 0.003$; nearly colorless.
$\gamma = 1.580 \pm 0.003$; yellow ocher (Ridgway's 17′–*).

A partial analysis of this specimen showed 8.6 per cent of MgO. Either the specimens of castanite are incorrectly labeled or castanite is identical with quetenite.

See Quetenite (p. 125).

CELADONITE.

Verona, Italy (U. S. N. M. 93080). Very minute fibers with + elongation.

$\alpha = 1.625 \pm 0.005$. $\gamma = 1.638 \pm 0.005$.

Pleochroic as usual.

CENOSITE.

Nordmark, Sweden (A. M. N. H.). Minute chestnut-brown crystals on chlorite. Optically −, 2V = medium large. Brownish and clouded in section and nonpleochroic.

$\alpha = 1.667 \pm 0.003$. $\beta = 1.681 \pm 0.003$. $\gamma = 1.683 \pm 0.003$.

CERITE.

1. Riddarhyttan, Sweden (U. of C.). The reddish-brown part of the specimen is made up of an aggregate of a number of minerals. Mineral A is in slight excess of B, and C and D occur in small amount.

A (agrees optically with bastnaesite). Colorless grains, uniaxial +.

$\omega = 1.722 \pm 0.003$. $\epsilon = 1.813 \pm 0.003$.

B = Cerite. Nearly colorless grains, pleochroic only in thick sections. Optically +, 2V = 25° ± 3° (measured), $\rho < v$ (very strong).

$\alpha = 1.817 \pm 0.003$; nearly colorless. $\beta = 1.817 \pm 0.003$. $\gamma = 1.821 \pm 0.003$; pale reddish.

C, optically +, 2V small, $\rho < v$ (rather strong), pleochroic.

$\alpha = 1.845 \pm 0.003$; pale pure green. $\beta = 1.852 \pm 0.003$. $\gamma = 1.878 \pm 0.003$; nearly colorless.

Probably toernebohmite.

D, a dark-brown, strongly pleochroic mineral with high index of refraction and strong birefringence.

2. Ytterby (U. of C.). Similar to No. 1.

CERVANTITE.

1. Cornwall, England (U. S. N. M., Shepard collection). Most of the material is perceptibly isotropic, but some is indistinctly birefracting.

$n = 1.88 \pm 0.02$.

2. Kern County, Calif. (U. of C.). Isotropic, with some indistinctly birefracting material.

$n = 1.98 \pm 0.01$ (about).

3. Kern County, Calif. (U. of C.). Yellow earthy alteration of stibnite. Almost entirely amorphous.

$$n = 1.99 \pm 0.01.$$

4. Western Australia (U. of C.). In powder, largely very finely fibrous, with strong birefringence and Z parallel to the fibers. Indices of refraction vary somewhat, probably owing to admixed amorphous material.

$$\alpha < 1.91. \qquad \gamma > 1.91.$$

5. Fords Creek, New South Wales (U. S. N. M. 82476). Not homogeneous. In part rather strongly birefracting with $n > 1.98$. In part with $n < 1.98$.

6. Utah (U. S. N. M. 48208). Indistinctly birefracting.

$$\beta = 2.05 \pm 0.03.$$

7. Knoppenberg, Austria (Cal. Min.). Optically −, 2E = 27° ± 2°, 2V = 15° ± 1°, dispersion slight. In lath-shaped crystals with X normal to the plates and Z parallel to the elongation. (This specimen is probably a carbonate.)

$$\alpha = 1.83 \pm 0.02. \qquad \beta = 2.04 \pm 0.02. \qquad \gamma = 2.04 \pm 0.02.$$

There are also many fibers with faint birefringence and + elongation.

$$n = 2.06 \pm 0.02.$$

See Stibiconite (p. 136).

CHALCANTHITE.

Chuquicamata, Chile (U. S. N. M.). Labeled "krohnkite." Optically −, 2E = 92° ± 3°, 2V = 56° ± 2° (measured), $\rho < v$ (perceptible). Nearly colorless in section.

$$\alpha = 1.511 \pm 0.003. \qquad \beta = 1.530 \pm 0.003. \qquad \gamma = 1.538 \pm 0.003.$$

CHALCOLAMPRITE.

Narsarsuk, Greenland (Brush Coll. 1671, Yale). Nearly colorless in section and clouded. Isotropic.

n averages about 1.87. Varies somewhat.

CHALCOMENITE.

Cerro de Cacheuta, Argentina (A. M. N. H.). Associated with azurite. Greenish blue and paler than azurite. In section pale greenish blue and nonpleochroic. Optically −, $2E_{Li} = 62° \pm 5°$, $2V_{Li} = 34°$ (measured), $\rho > v$ (extreme).

The red part of the hyperbolae cross (2V = 0 for blue or green light).

$$\alpha = 1.710 \pm 0.003. \qquad \beta = 1.731 \pm 0.003. \qquad \gamma = 1.732 \pm 0.003.$$

CHALCOPHANITE.

1. Ogdensburg, N. J. (U. of C.). Nearly opaque, n extreme, birefringence strong, pleochroism strong.

2. Sterling Hill, N. J. (A. M. N. H.). Uniaxial –, strongly pleochroic, ϵ = deep red, ω = nearly opaque.

$$\omega > 2.7.$$

3. Leadville, Colo. (G. F. Loughlin, U. S. Geological Survey). Fine, fibrous crusts, uniaxial –, strongly pleochroic and nearly opaque. Fibers tend to lie on base. Birefringence is extreme. ϵ is somewhat above 2.72.

4. New Discovery dump, Leadville, Colo. (G. F. Loughlin). Coarsely crystalline. Uniaxial –, lie on very perfect basal cleavage. Birefringence extreme, strongly pleochroic; ϵ = deep red, ω = nearly opaque.

ω is much above 2.72. ϵ is near 2.72.

CHALCOSIDERITE.

1. Arizona (U. of C.). Dark-green crystals. In section pale green and nonpleochroic. Optically –, $2E_{Na} = 44° \pm 2°$, $2V_{Na} = 23° \pm 1°$ (measured), $2E_{Li} = 53° \pm 2°$, $2V_{Li} = 28° \pm 2°$ (measured), $\rho > v$ (very strong), crossed very strong.

A section normal to Bx_a gives an interference figure which is not black, but when turned so that the hyperbolae are crossed the figure is bordered by blue in one pair of opposite quadrants and red in the other pair. In plane polarized light this section gives no extinction in white light but abnormal red, blue, and green interference colors as the section is turned on the stage of the microscope. Other sections show sharp extinction in white light.

$\alpha = 1.773 \pm 0.003$. $\beta = 1.840 \pm 0.003$. $\gamma = 1.845 \pm 0.003$.

The optical properties indicate a monoclinic mineral with $X = b$.

2. Wherl Phoenix, Cornwall, England (U. S. N. M. 47524). Bright-green drusy crystals. Optically –, $2E_{Na} = 44° \pm 3°$, $2V_{Na} = 24° \pm 2°$ (measured), $2E_{Li} = 52° \pm 3°$, $2V_{Li} = 28° \pm 2°$ (measured), $\rho > v$ (very strong), crossed very strong. In thin section nearly colorless, in thicker pieces pleochroic.

$\alpha = 1.775 \pm 0.003$; colorless. $\beta = 1.840 \pm 0.003$. $\gamma = 1.844 \pm 0.003$; pale green.

CHENEVIXITE.

American Eagle mine, Tintic, Utah (U. S. N. M. 44549). Pale green, opal-like. Very finely crystalline to submicroscopic. Unsatisfactory for optical data.

$$n = \text{about } 1.88.$$

Birefringence in some of the material rather strong.

CHILDRENITE.

1. Tavistock, England (U. S. N. M. 84674). Optically –, 2V = medium, $\rho > v$ (strong).

$\alpha = 1.643 \pm 0.003$. $\beta = 1.678 \pm 0.003$. $\gamma = 1.684 \pm 0.003$.

2. Hebron, Maine (U. S. N. M. 82429). Optically –, 2E = 70° ± 5° 2V = 40° ± 3° (measured), $\rho < v$ (strong).

$\alpha = 1.631 \pm 0.003$. $\beta = 1.660 \pm 0.003$. $\gamma = 1.664 \pm 0.003$.

This mineral is probably eosphorite.

CHLOROMAGNESITE.

Artificial $MgCl_2$ made by the ignition of $MgCl_2 + 6H_2O$. Fibers and plates (001). Uniaxial –.

$\omega = 1.675 \pm 0.005$. $\epsilon = 1.59 \pm 0.01$.

Rapidly takes up water.

CHLOROPAL.

Hungary (U. S. N. M. 51644). Fibrous.

$\alpha = 1.625 \pm 0.01$. $\gamma = 1.655 \pm 0.01$.

Not satisfactory for further data.

CHONDRODITE.

1. Brewster, N. Y. Reddish-brown crystals. Optically +, 2V large.

$\alpha = 1.625 \pm 0.005$ (varies ± 0.01). $\beta = 1.636 \pm 0.005$ (varies ± 0.01). $\gamma = 1.655 \pm 0.005$ (varies ± 0.01).

2. Nya Kopparberg, Sweden. Optically +, 2V large.

$\alpha = 1.605 \pm 0.005$ (varies ± 0.01). $\beta = 1.618 \pm 0.005$ (varies ± 0.01). $\gamma = 1.635 \pm 0.005$ (varies ± 0.01).

CHROMITE.

1. North Carolina. Red-brown in powder.

$n = 2.16$.

2. Nottingham, Pa. Contains Cr_2O_3, 51.21 per cent; Fe (as Fe_2O_3) + Al_2O_3, 48.70 per cent.

$n = 2.08$.

CHURCHITE.

Cornwall, England (U. S. N. M. 51447). Perceptibly uniaxial and +. The crystals are rectangular in outline, wedge out on the long edges, and at the short edge have a face normal to the tablets (fig. 7). Z is sensibly normal to the plates. If turned on edge the plates give extinction angles up to 1½° (probably parallel extinction).

$\alpha = 1.620 \pm 0.003$. $\beta = 1.620 \pm 0.003$. $\gamma = 1.654 \pm 0.003$.

The optical data and habit indicate an orthorhombic mineral with 2V nearly or quite 0.

CIMOLITE.

1. Norway, Maine (U. S. N. M. 16177). Rather clear, isotropic grains.

$n = 1.564$.

Considerable admixed quartz occurs in small, well-formed crystals.

2. Bilin, Bohemia. Variety anandite (U. S. N. M. 4076). Not homogeneous; consists in part of amorphous material in which n is about 1.48 and in part of birefracting shreds that have a considerably higher index of refraction.

This mineral, in common with the other clay-like minerals, needs further study.

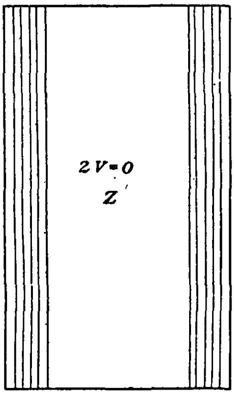

FIGURE 7.—Optical orientation of tabular crystals of churchite.

CLAUDETITE.

Schmöllnitz, Hungary (Col. Roebling). Optically +, Y is normal to the plates.

$\alpha = 1.871 \pm 0.005$. $\beta = 1.92 \pm 0.02$.
$\gamma = 2.01 \pm 0.01$.

It is difficult to turn the plates on edge.

CLINOCLASITE.

Mammoth mine, Tintic, Utah (U. S. N. M. 48108). Optically −, 2V medium, pleochroic.

$\alpha = 1.73 \pm 0.01$; pale blue-green. $\beta = 1.870 \pm 0.01$; light blue-green. $\gamma = 1.91 \pm 0.02$; benzol-green.

CLINOHEDRITE.

Franklin, N. J. (U. S. N. M. 84365). Optically −, 2V large, Z normal to cleavage.

$\beta = 1.670 \pm 0.003$.

Birefringence = 0.01.

COBALT CHALCANTHITE.

1. Labeled bieberite. Bieber, Hesse (Col. Roebling). Rose-red coating, pale rose-red in section. Very finely crystalline. Optically −, 2V medium.

$\alpha = 1.532 \pm 0.005$. $\beta = 1.542 \pm 0.005$. $\gamma = 1.547 \pm 0.005$.

This is no doubt a dehydration product of bieberite.

2. Artificial. Pale rose-pink. Optically −, 2V medium, dispersion not strong, faintly pleochroic.

$\alpha = 1.530 \pm 0.003$; eosine pink (1d).[25] $\beta = 1.548 \pm 0.003$.
$\gamma = 1.550 \pm 0.003$; pale rose-pink (71f).[25]

COERULEOLACTITE.

Gen. Trimble's mine, East Whiteland Township, Chester County, Pa. Fibrous crusts. Radiating fibers that have parallel extinction and positive elongation. Nearly or quite uniaxial and optically +.

$\omega = 1.580 \pm 0.005$. $\epsilon = 1.588 \pm 0.005$

COLLYRITE.

Fichtelgebirge (Col. Roebling). Dull, opaline. Mostly isotropic.

$n = 1.555$.

This mineral agrees with halloysite that is low in water and has about the composition of kaolinite.

COLUMBITE AND TANTALITE.

1. Canon City, Colo. (U. S. N. M.). Columbite. Specific gravity 5.48. Nearly opaque, faintly pleochroic.

$\beta = 2.45$ (about).

Birefringence strong.

2. Dakota (U. of C.). Tantalite. Optically +, 2V large. Rather strongly pleochroic in red brown, absorption Z > X.

$\alpha = 2.26 \pm 0.02$. $\beta = 2.32 \pm 0.02$. $\gamma = 2.43 \pm 0.02$.

3. Alabama (U. S. N. M. 8315). Tantalite. Specific gravity 7.30. Optical properties variable. γ ranges from less than 2.30 to more than 2.40. Strongly pleochroic in red-brown, Z > X.

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[25] Ridgway, Robert, Color standards and nomenclature, 1912.

4. Amelia, Va. Tantalite (probably manganotantalite). Specific gravity, 6.5. Optically +, 2V large, $\rho < v$ (moderate), strongly pleochroic.

$\alpha = 2.19 \pm 0.01$; pale red. $\beta = 2.25 \pm 0.01$; blood-red.
$\gamma = 2.34 \pm 0.01$; deep blood-red.

Evidently as tantalum increases the specific gravity increases, the index of refraction decreases, and the birefringence increases.

5. Ferrocolumbite. Haddon, Conn. (U. S. N. M. 80012). Probably optically −, translucent only on very thin edges. Absorption rather strong, Z > X.

$$\beta_{Li} = 2.40 \pm 0.03.$$

Birefringence extreme.

CONICHALCITE.

1. No locality (Cal. Min.). Emerald-green, botryoidal coating. Green, slightly pleochroic, fibrous crusts. Optically +, 2V very small, Z parallel to elongation.

$\alpha = 1.765 \pm 0.005$. $\beta = 1.77$. $\gamma = 1.790 \pm 0.005$.

The indices differ a little in different layers of the crusts.

2. American Eagle mine, Tintic district, Utah. Type, analyzed by Hillebrand (U. S. N. M.). Emerald-green, reniform coating. In section fibrous, pale green, and slightly pleochroic. Optically +, nearly or quite uniaxial. No dispersion noticed. Extinction is parallel, and Z is along the fibers.

$\omega = 1.778 \pm 0.003$. $\epsilon = 1.801 \pm 0.003$.

The indices differ somewhat in the different crusts.

CONNARITE.

"Röttiste," Röttis, Saxony (A. M. N. H.). Sensibly uniaxial −, X is normal to cleavage, pleochroism is very faint. The indices of refraction vary 0.02.

$$\omega = 1.59 \pm 0.02.$$

Birefringence about 0.03.

COOKEITE.

Pala, San Diego County, Calif. (analyzed by W. T. Schaller). Hexagonal plates with Bx_a normal to the plates. The plates have a uniaxial center and are divided into hexagonal segments. Each segment has the plane of the optic axis parallel to the hexagonal edge. The optical properties are somewhat variable. Optically +, 2E ranges from 0 to 90°.

$$\beta = 1.58 \pm 0.01.$$

Birefringence about 0.03.

The plates have a narrow border with $\beta = 1.54 \pm 0.01$.

COPIAPITE.

1. Atacama, Chile (U. S. N. M. 80516). Optically +, $2V = 69° \pm 5°$ (indices), $\rho > v$ (rather strong). X normal to plates, Z parallel to elongation.

$\alpha = 1.530 \pm 0.005$; nearly colorless. $\beta = 1.550 \pm 0.005$; nearly colorless. $\gamma = 1.592 \pm 0.003$; yellow.

2. Knoxvillite. Napa County, Calif. (A. M. N. H.). Pale yellow-green powder. Minute tabular crystals that have a rhombic outline and an angle of 77½° between the edges. Optically +, $2V = 67° \pm 1°$ (indices), $\rho > v$ (strong). X is normal to the plates and Y bisects the acute angle of the rhombs. Plates turned on edge show parallel extinction. Distinctly pleochroic.

$\alpha = 1.507 \pm 0.001$; colorless. $\beta = 1.529 \pm 0.001$; colorless. $\gamma = 1.576 \pm 0.001$; yellow green.

The mineral is probably orthorhombic.

3. No locality (U. of C.). Labeled "Molybdite." In thin plates resembling those of knoxvillite but with the acute angle truncated and with an angle of about 72° between the sides. $2E = 72° \pm 3°$, $2V = 45° \pm 2°$ (measured). Optically +, $2V = 49° \pm 5°$ (indices), $\rho > v$ (strong). X is normal to the plates and Y bisects the acute angle.

$\alpha = 1.540 \pm 0.003$; nearly colorless. $\beta = 1.550 \pm 0.003$; nearly colorless. $\gamma = 1.600 \pm 0.003$; pale canary-yellow.

4. Leona Heights, Calif. (analyzed by W. T. Schaller). Six-sided tabular crystals with an angle of $77\frac{1}{2}° \pm 1°$ between the sides. Optically +, $2V = 52° \pm 3°$ (indices), X emerges from the plates and Z is parallel to the longer edge and bisects the angle (obtuse) of the other two.

$\alpha = 1.530 \pm 0.003$; nearly colorless. $\beta = 1.541 \pm 0.003$; nearly colorless. $\gamma = 1.587 \pm 0.003$; canary-yellow.

5. No locality (W. T. Schaller). Similar to No. 4. Optically +, 2V moderate. $\rho > v$ (rather strong).

$\alpha = 1.525 \pm 0.005$. $\beta = 1.543 \pm 0.003$. $\gamma = 1.590 \pm 0.003$.

6. Montpelier, Iowa (R. M. Wilke, of Palo Alto, Calif.). Quenstedtite. Pale-sulphur to greenish-yellow crusts. In section very minute fibers and plates. Optically +, 2V small, X is nearly normal to the plates.

$\alpha = 1.530 \pm 0.003$. $\beta = 1.54 \pm 0.01$. $\gamma = 1.600 \pm 0.003$.

7. Blythe, Calif. Optically +. 2V moderate, $\rho > \upsilon$ (strong). X nearly normal to the cleavage. Section normal to X shows inclined extinction.

$\alpha = 1.510 \pm 0.005$, colorless.

$\beta = 1.535 \pm 0.003$, colorless. $\gamma = 1.575 \pm 0.003$, yellow.

The available optical data on copiapite and some related iron sulphates are assembled in the accompanying table for comparison. Optically sideronatrite is very much like some copiapite, except for its fibrous structure. Castanite and quetenite are very much alike and are probably identical, provided the specimens examined are correctly labeled, and there seems no reason to suspect that they are not. They differ sufficiently from copiapite to make it seem probable that they represent a distinct species. The other ten specimens, including ihleite, janosite, copiapite, quenstedtite, and knoxvillite, probably represent a single mineral, copiapite. They occur in similar tabular crystals, and all show the same optical orientation and similar pleochroism. However, they differ considerably in their indices of refraction and must differ somewhat in their chemical composition.

TABLE 3.—*Optical properties of copiapite and some related minerals.*

Name and locality.	Habit.	α	β	γ	Optical character.	2V and dispersion.	Optical orientation.
Sideronatrite, Sierra Gordo, Chile.	Fibers.........	1.508	1.525	1.586	+	56° $\rho > \upsilon$	X ⊥ cleavage. Z // fibers.
Knoxvillite, Napa County, Calif.	Rhombic plates, <77½°	1.508	1.528	1.576	+	66° $\rho > \upsilon$	X=*c*. Y bisects acute angle.
Copiapite,[a] Copiapo.....	Orthorhombic.	1.506	1.529	1.573	+	73° 31′	X near *c*. Z=*a*.
Ihleite,[a] Vignerea, Elba.	Rhombic or six-sided plates, (001) 78°.	1.507	1.531	1.575	+	74° 43′	X=*c*. Z bisects acute angle.
Ihleite,[a] Capo d'Arco, Elba.	.....do.........	1.509	1.532	1.577	+	72° 55′	Do.
Castanite, Chile.........	Massive.......	1.527	1.532	1.583	+	34° $\rho > \upsilon$	
Copiapite, Blythe, Calif.	....	1.510	1.535	1.575	+	Moderate $\rho > \upsilon$ strong.	X nearly ⊥ plates.
Quetenite, Quetena, Chile.	....	1.530	1.535	1.582	+	32° $\rho > \upsilon$	X or Y. ⊥ cleavage.
Quenstedtite,[b] Montpelier.	Fibers, plates.	1.530	1.54	1.600	+	Small.	X ⊥ plates.
Copiapite, Leona Heights, Calif.	Six-sided tablets, <77½°.	1.530	1.541	1.587	+	52°	X ⊥ plates. Z // long edge.
Copiapite (?)...........	Six-sided tablets, (001).	1.525	1.543	1.590	+	Rather small.	X=*c*. Z // long edge.
Janosite[c]...............	Tablets, (001) 72°.	1.520	1.547	1.572	—	Near 90°	X ⊥ plates.
Copiapite, Atacama, Chile.	Plates, {101} {001}.	1.530	1.550	1.592	+	69°	X=*c*. Z // elongation.
Copiapite, California....	Six-sided tablets, <72°.	1.540	1.550	1.600	+	45° $\rho > \upsilon$	X=*c*. Z // short edge.

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[a] Manasse, Ernesto, Identita fra lo considetta ihleite elbana e lo copiapite: Soc. toscana sci. nat. Proc. verb., vol. 20, pp. 1-14, Pisa, 1911.

[b] The original quenstedtite from Chile was optically negative.

[c] Weinschenk, E., Ueber den Janosit und seine Identität mit Copiapit: Földtani Közlöny, vol. 36, pp. 224-228, 1906.

CORKITE.

Beaver County, Utah (W. T. Schaller). Biaxial, optically $-$.

$$\beta = 1.930 \pm 0.01.$$

Birefringence weak. The plates show abnormal green interference colors.

CORNWALLITE.

Cornwall, England (Col. Roebling). Green spherulites. Under the microscope the material is seen to be made up of very fine interwoven fibers in spherulites, with concentric layers having somewhat variable optical properties. The optical properties are not entirely satisfactory. The following data are believed to be correct but may be partly in error. Optically $+$ with a small optic angle. Most of the fibers show negative elongation but some show positive elongation.

$\alpha = 1.81$ approximately. $\beta = 1.815 \pm 0.003$ in considerable part. $\gamma = 1.85$ approximately.

CORUNDOPHILITE.

Chester, Mass. (U. S. N. M. 18180). Deep-green plates. Optically $+$, 2E variable but averages about 50°, $2V = 31°$ approximately, $\rho < v$ (rather strong), rather strongly pleochroic.

$\alpha = 1.607 \pm 0.003$; bright green. $\beta = 1.607 \pm 0.003$; bright green. $\gamma = 1.613 \pm 0.003$; nearly colorless.

CROCIDOLITE.

Locality unknown (U. of C.). Very minute fibers. Optically $+$, 2V moderate (?).

$$\beta = 1.70 \pm 0.01.$$

Birefringence rather low.

CROCOITE.

Beresowsk, Urals (U. of C.). Optically $+$, $2V = 57° \pm$ (indices), $\rho > v$ (very strong).

$\alpha_{Li} = 2.29 \pm 0.02.$ $\beta_{Li} = 2.36 \pm 0.02.$ $\gamma_{Li} = 2.66 \pm 0.02.$

CRONSTEDTITE.

Kuttenberg, Bohemia (U. S. N. M. 52035). Strongly pleochroic, nearly opaque to dark reddish brown, translucent only in thinnest splinters.

$$n = 1.80 \pm 0.01.$$

CROSSITE.

1. North of Berkeley, Calif. (U. S. Geol. Survey). Optically −, 2V rather large, $\rho < v$ (very strong). Sections nearly normal to X give sharp, parallel extinction with the optic plane across the cleavage fragments. Sections normal to Z give no extinction in white light but abnormal interference colors due to the strong dispersion of the bisectrices. Strongly pleochroic. X = pale yellow to nearly colorless, Y = sky blue, Z = violet. The optical properties differ somewhat.

$$\beta = 1.670 \pm 0.005.$$

Birefringence weak.

$Z = b$, $Y_{Na} \wedge c$ about 7° and differs according to the color of the light.

2. Southern California, from a breccia deposit. Optically −, 2V rather large, $\rho > v$ (very strong), $Z = b$, gives no extinction in white light owing to strong dispersion, $Y_{Na} \wedge c$ about 10°. Pleochroic.

$\alpha = 1.657 \pm 0.003$; pale yellowish, nearly colorless. $\beta = 1.659 \pm 0.003$; deep blue. $\gamma = 1.663 \pm 0.003$; deep violet.

CUPRODESCLOIZITE.

1. Arizona. (Type analyzed by R. C. Wells.) Fibers with negative elongation and strong pleochroism. Optically −, 2V = 73° about (indices). $\rho > v$ (strong).

$\alpha = 2.17 \pm 0.02$; nearly colorless. $\beta = 2.26 \pm 0.02$; reddish brown. $\gamma = 2.32 \pm 0.02$; reddish brown.

2. Oruro, Bolivia. Dark olive-green grains. The powder is canary-yellow. Optically −, 2E = 120° ± 10°, 2V = 47° ± 5° (measured). $\rho > v$ (strong). In transmitted light the material is canary-yellow and weakly pleochroic.

$\alpha_{Li} = 2.21 \pm 0.01$. $\beta_{Li} = 2.31 \pm 0.01$. $\gamma_{Li} = 2.33 \pm 0.01$.

CUPROTUNGSTITE.

Cave Creek, Ariz. (analyzed by W. T. Schaller). Green in section and very finely crystalline.

$$n = 2.15 \pm 0.02.$$

Birefringence strong.

CUSPIDINE.

Vesuvius, Italy (U. S. N. M. 85206). Optically +.

$\alpha = 1.590 \pm 0.003$. $\beta = 1.595 \pm 0.003$. $\gamma = 1.602 \pm 0.003$.

CYANOTRICHITE.

1. Tintic district, Utah (A. M. N. H.). Wool-like aggregates of minute blue fibers. Optically +, $2V = 83° \pm 5°$ (indices). Z is parallel to the length, X emerges from the flat face, pleochroic.

$\alpha = 1.588 \pm 0.003$; nearly colorless. $\beta = 1.617 \pm 0.003$; pale blue.
$\gamma = 1.655 \pm 0.003$; bright blue.

2. Tintic district, Utah (F. M. N. H., Chicago).

$\beta = 1.616$; otherwise similar to No. 1.

3. Chile (U. of C.). Long, flat, greenish-blue laths and fibers. Optically—, nearly uniaxial, 2E = about 10°, $2V = 6° \pm 2°$, dispersion not perceptible. X is normal to the laths and Z parallel to the elongation. It is very difficult to turn the laths on any but the flat face.

$\alpha = 1.720 \pm 0.003$. β and $\gamma = 1.724 \pm 0.003$.

This is probably not cyanotrichite. Its optical properties do not correspond with those of any known species.

CYPRUSITE.

1. Cyprus (Col. Roebling). Very finely crystalline, in part fibrous, in part nearly isotropic and probably a metacolloid. In section canary-yellow. Optically—, 2V = medium large.

$n = 1.540$ about.

Birefringence low.

The specific gravity given for cyprusite (1.7 to 1.8) is exceptionally low for a mineral of its composition, as is also the index of refraction of this specimen.

2. Cyprus (Prof. Lacroix). Minute crystals, hexagonal outline. Probably rhombs with prominent base. Sensibly uniaxial, optically —.

$\omega = 1.830 \pm 0.005$. $\epsilon = 1.72 \pm 0.01$.

This is probably jarosite and agrees more nearly with the original description of cyprusite than does specimen No. 1.

DANALITE.

Rockport, Mass. (U. S. N. M. 45943). Colorless, clouded, isotropic.

$n = 1.737 \pm 0.003$.

DAPHNITE.

Camborne, Cornwall, England (Col. Roebling). Dark-green chloritic mineral in fine aggregates of fibers and basal plates. Optically—, 2V near 0, pleochroic.

$\alpha = 1.643 \pm 0.003$; yellowish, nearly colorless. $\beta = 1.649 \pm 0.003$; green. $\gamma = 1.649 \pm 0.003$; olive-green.

DARAPSKITE.

Santa Catalina, Chile (Col. Roebling). Glassy crystals. Optically—, $2E = 40° \pm 2°$, $2V = 27° \pm 1°$ (measured), $2V = 26°$ (indices), $\rho > v$ (rather strong). Perfect cleavage sensibly normal to X and this section shows polysynthetic twinning similar to that of plagioclase, with the composition plane sensibly normal to the cleavage. Extinction on this section against the lamellae is symmetrical and the angle of Z to the lamellae $= 12°$. There is another perfect cleavage or parting parallel to the composition plane of the twinning.

$\alpha = 1.391 \pm 0.005$. $\beta = 1.481 \pm 0.003$. $\gamma = 1.486 \pm 0.003$.

The mineral is probably monoclinic, with $X = b$, $Z \wedge c = 12°$, composition plane $\{100\}$, perfect cleavages $\{100\}$ and $\{010\}$.

DAUBREEITE.

Cerro de Taza, Bolivia (Col. Roebling). Yellow, earthy powder. Very finely crystalline.

$\beta = 1.91 \pm 0.01$.

Birefringence about 0.01.

DAVIESITE.

Mina Beatriz, Sierra Gorda, Mexico (Col. Roebling). Clear crystals and fibers. Optically +, 2V nearly 90°, $\rho < v$ (rather strong). May be optically—, 2V nearly 90°, $\rho > v$ (rather strong). The axial angle is so near to 90° that the optical character is uncertain.

$\alpha = 1.744 \pm 0.003$. $\beta = 1.752 \pm 0.003$. $\gamma = 1.760 \pm 0.003$.

DAWSONITE(?)

Siena, Italy (U. S. N. M. 46463). Cotton-like aggregates of minute fibers. The elongation is + and extinction is parallel. Probably optically +, absorption is rather strong.

$\alpha = 1.505 \pm 0.003$; gray and clouded. $\beta = 1.515 \pm 0.005$; gray and clouded. $\gamma = 1.535 \pm 0.005$; clear and colorless.

This is entirely different from the original dawsonite from Montreal, as described by Graham.[26]

DERBYLITE.

Mina Geraes, Brazil (A. M. N. H.). Minute crystals. Uniaxial +, or a very small axial angle.

$$\omega_{Li} = 2.45 \pm 0.02. \qquad \epsilon_{Li} = 2.51 \pm 0.02.$$

DESCLOIZITE.

Mammoth mine, Arizona (U. of C.). Orange-red crystals; 2V nearly 90°, optically —, $\rho < v$ (rather strong).

$$\alpha = 2.185 \pm 0.01. \qquad \beta = 2.265 \pm 0.01. \qquad \gamma = 2.35 \pm 0.01.$$

DESTINEZITE.

Visé, Belgium (Prof. Lacroix). Nearly colorless, earthy. Under the microscope it is seen to be made up of minute tabular crystals with a hexagonal outline. Optically +, 2V small, $\rho > v$ (rather strong). X is nearly normal to the tabular face and Z′ makes an angle of about 16° to the long edge. When turned on the face forming the long edge the crystals show the emergence of Y and give an extinction Z′ to elongation of about 14°. The mineral is probably triclinic.

$$\alpha = 1.615 \pm 0.005. \qquad \beta = 1.625 \pm 0.005. \qquad \gamma = 1.665 \pm 0.005.$$

DIABANTITE.

1. Bergen Hill, N. J. (U. S. N. M. 13562). Very minute shreds "tangled together." Optically −, 2V small (?), dark olive-buff in section and faintly pleochroic.

$$\beta = 1.605 \pm 0.005.$$

Birefringence rather strong.

2. Wilson's quarry, Plainfield, N. J. (E. T. Wherry). Optically −, 2V = rather large, Z is parallel to the elongation of the fibers which tend to lie on a face normal to X. Pleochroic in gray-green, with absorption Z > Y > X.

$$\alpha = 1.54 \pm 0.01. \qquad \beta = 1.59 \pm 0.01. \qquad \gamma = 1.605 \pm 0.005.$$

Measurements of the indices differ slightly.

DIADOCHITE.

1. Kremnitz, Hungary (Col. Roebling). Brown, opaline. Perceptibly isotropic, clear yellow, and homogeneous.

$$n = 1.618.$$

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[26] Graham, R. P. D , Roy. Soc. Canada Trans., vol. 2, section 4, p. 165, 1908.

2. Frelingyiote, Styria, Austria (U. S. N. M. 48450). Cryptocrystalline. Birefringence is moderate to rather strong.

$$n > 1.70.$$

Probably not diadochite.

DICKINSONITE.

Branchville, Conn. (U. S. N. M.). Optically +, 2V moderate, $\rho > v$ (rather strong), Y is nearly normal to the plates, $X = b$, pleochroic.

$\alpha = 1.658 \pm 0.003$; pale olive-green. $\beta = 1.662 \pm 0.003$; paler olive-green. $\gamma = 1.671 \pm 0.003$; very pale yellowish green.

DIETRICHITE.

Felsöbánya, Hungary (A. M. N. H.). White fibers. Optically + (it may possibly be −), 2V large, fibers turned so that X is normal to them show the angle Z to elongation 29° ±. Fibers nearly normal to Y show perceptibly parallel extinction. The mineral is therefore probably monoclinic, with $X = b$ and $Z \wedge c = 29° \pm$.

$\alpha = 1.475 \pm 0.003$. $\beta = 1.480 \pm 0.003$. $\gamma = 1.488 \pm 0.003$.

DIETZEITE.

Atacama, Chile (A. M. N. H.). Sulphur-yellow glassy crystals. Optically −, 2V large, $\rho < v$ (very strong), inclined dispersion very strong. Cleavage pieces are sensibly normal to X and show sharp extinction. Hence the mineral is probably monoclinic with cleavage (100) perfect. $Y = b$.

$\alpha = 1.825 \pm 0.005$. $\beta = 1.842 \pm 0.005$. $\gamma = 1.857 \pm 0.005$.

DIHYDRITE.

1. Dihydrite, Bogolo, Portugal (Col. Roebling). Dark-green crystals. 2V about 90°, in part optically −, $\rho > v$ (strong), in part optically +, $\rho < v$ (strong), axial dispersion not noticed, pleochroism faint in blue-green with absorption $X > Z$.

$\alpha = 1.719 \pm 0.003$. $\beta = 1.763 \pm 0.003$. $\gamma = 1.805 \pm 0.003$.

2. Pseudomalachite, Hungary (U. of C.). Green, malachite-like crusts. Very finely fibrous, Z nearly parallel to the fibers.

$\alpha = 1.73 \pm 0.01$. $\gamma = 1.807 \pm 0.005$.

DOUGLASITE.

Douglashall, Westerregeln, Germany (Col. Roebling). Perceptibly uniaxial, optically +; the crystals tend to lie on the base.

$\omega = 1.488 \pm 0.003$. $\epsilon = 1.500 \pm 0.003$.

DUFRENITE.

1. Saxony (U. of C.). Crystals with zonal growths showing variable optical properties, especially the axial angle. All show Z normal to the cleavage. Cleavage pieces show no extinction in white light but abnormal green, orange, and red interference colors over a wide angle. Fibers turned normal to the plane of Y and Z show sharp, parallel extinction in white light.

A. The greater part of the material is optically +, 2V medium to 90°, $\rho > \upsilon$ (marked), crossed extreme, pleochroism intense, absorption $Z > X > Y$.

$\alpha = 1.830 \pm 0.005$; bright green (when 2V is small, brownish).
$\beta = 1.840 \pm 0.005$; very pale yellowish to nearly colorless.
$\gamma = 1.885 \pm 0.005$; dark reddish brown.

B. 2V may pass through 90° and some of the crystals may be optically −, with large 2V and $\rho < \upsilon$ (marked). Otherwise similar to A.

C. Some of the crystals are optically +, 2V small to large, $\rho < \upsilon$. (marked). One fragment gave:

$2E_{red} = 54° \pm 5°$, $2V_{red} = 28° \pm 3°$. $2E_{Na} = 70° \pm 3°$, $2V_{Na} = 36° \pm 3°$

Strongly pleochroic.

$\alpha = 1.840$. X = light yellow-brown. Y = dark brown.

2. Krauerite. Uelersreuth bei Hof (U. of C.). Dark green, botryoidal coatings of fibers. Chiefly type C. Optically +, 2V large, $\rho < \upsilon$ (marked).

One piece gave $2E_{Na} = 53° \pm 5°$, $2V_{Na} = 28° \pm 3°$, $2E_{red} = 0 \pm$, $2V_{red} = 0+$; another $2E_{Na} = 85° \pm 5°$, $2V_{Na} = 43° \pm 3°$. Some pieces have larger or smaller values for 2V. Fibers tend to lie on cleavage normal to Z and give fairly sharp extinction with abnormal bluish-green interference colors. Y is parallel to the elongation. Pleochroism intense; absorption $Z > Y > X$.

$\alpha = 1.840 \pm 0.005$; pale yellowish.
$\beta = 1.845 \pm 0.005$; rather dark reddish brown, becoming bright green as 2V becomes small.
$\gamma = 1.89 \pm 0.01$; dark reddish brown to dark green.

One piece showed 2V small, $\rho < v$, X = pale yellowish, Y = grass-green. Little of type A, with $\rho > v$.

These data show that for dufrenite 2V appears to decrease from large in type C, with $\rho < v$ to 0, then to increase with $\rho > v$ to 90°, and to become optically − with $\rho < v$ and to decrease. The value of γ remains from 1.885 to 1.890; the value of the ray that vibrates parallel to the cleavage and normal to the fibers remains practically constant at 1.840, but the value of the ray that vibrates in the direction of elongation varies greatly. It is β in type C and has a value of 1.845 ±, but it is α in type A and has a value of 1.830 ±.

DUFRENOYSITE.

Binnenthal, Switzerland (U. S. N. M. 84125). Dark red-brown in section and nearly opaque. Properties not entirely satisfactory.

$$n_{Li} > 2.72.$$

Birefringence very strong.

DUMORTIERITE.

California (U. S. N. M. 85068). Optically −, 2V small, pleochroic but pale in color, X parallel to length.

$\alpha = 1.670 \pm 0.003$; pale blue-violet.
$\beta = 1.691 \pm 0.003$; nearly colorless.
$\gamma = 1.692 \pm 0.003$; nearly colorless.

DURANGITE.

Durango, Mexico (U. S. N. M. 81712). Optically −, 2V = 57° ± (indices), dispersion not perceptible, pleochroic.

$\alpha = 1.634 \pm 0.003$; orange-yellow.
$\beta = 1.673 \pm 0.003$; pale orange-yellow.
$\gamma = 1.685 \pm 0.003$; nearly colorless.

DURDENITE.

1. Honduras (U. of C.). Pale greenish-yellow pyramidal prisms. Optically −, $2E_{Na} = 44° \pm 2°$, $2V_{Na} = 22° \pm 1°$ (measured), 2V = 21° ± (indices), $\rho > v$ (very strong). X ⊥ a face or more likely a perfect cleavage. Two other perfect cleavages (possibly crystal faces) occur normal to this one and with an angle of about 72° between them. Y bisects the acute angle between these cleavages. Pleochroism is strong and absorption $Z \geqq Y > X$.

$\alpha = 1.702 \pm 0.005$; nearly colorless.
$\beta = 1.955 \pm 0.005$; pale yellow with a greenish tinge.
$\gamma = 1.965 \pm 0.005$; rather pale sulphur-yellow.

The mineral appears to be orthorhombic.

2. Calaveras County, Calif. (U. of C.). Labeled "Tellurium." Pale greenish-yellow spherulites coating fracture surfaces on a telluride ore. Optically −, $2E=48° \pm 3°$, $2V_{Na}=24° \pm 2°$ (measured), $\rho > v$ (very strong), tend to lie on a cleavage normal to X.

$\alpha=1.710 \pm 0.005$. $\beta=1.94 \pm 0.01$. $\gamma=1.95 \pm 0.01$.

The optical properties are identical with those of durdenite, for which mineral California is a new locality.

DYSANALYTE.

Magnet Cove, Ark. (U. S. N. M. 51431). Cube. Isotropic, clouded and dark brown, nearly opaque in section.

$n=2.33 \pm 0.02$.

ECDEMITE.

Långban, Sweden (U. S. N. M.). Yellow-green coating of very fine crystals. Uniaxial −, cleavage {001}.

$\omega_{Li}=2.32 \pm 0.02$. $\epsilon_{Li}=2.25 \pm 0.02$.

EGLESTONITE.

Terlingua, Tex. (U. S. N. M. type material). Probably isotropic with anomalous birefringence.

$n_{Li}=2.49 \pm 0.02$.

EMMONSITE.

Cripple Creek, Colo. (U. S. N. M. 86846). Optically −, 2V small, $\rho > v$ (strong), fibers and plates, colorless in section.

$\alpha=1.95 \pm 0.02$. $\gamma=2.10 \pm 0.02$.

ENDLICHITE.

Hillsboro, N. Mex. (U. S. N. M. type). Hexagonal prisms. Uniaxial −.

$\omega=2.25 \pm 0.01$. $\epsilon=2.20 \pm 0.01$.

ENIGMATITE.

Naujakasik, Greenland (Princeton No. 3431).

$\alpha=1.80 \pm 0.01$.

Birefringence rather low. Pleochroism very strong. X = pale reddish brown, Z = nearly opaque.

EOSPHORITE.

1. Branchville, Conn. (U. S. N. M.). Optically –, 2V medium, $\rho < v$ (strong).

$\alpha = 1.633 \pm 0.003$. $\beta = 1.656 \pm 0.003$. $\gamma = 1.662 \pm 0.003$.

2. Hebron, Maine. Labeled "Childrenite" (U. S. N. M. 82429). Optically –, 2E = 70° ± 5°, 2V = 40° ± 3° (measured), $\rho < v$ (strong).

$\alpha = 1.631 \pm 0.003$. $\beta = 1.660 \pm 0.003$. $\gamma = 1.664 \pm 0.003$.

This mineral is no doubt eosphorite.

EPISTOLITE.

Tulup, Greenland (U. S. N. M.). White, pearly, micaceous plates. Optically –, Z nearly normal to cleavage. 2V near 90°.

$\alpha = 1.610 \pm 0.005$. $\beta = 1.650 \pm 0.005$. $\gamma = 1.682 \pm 0.005$.

ERINITE.

Mammoth mine, Tintic, Utah (U. S. N. M. 48112). Small green fibers. Z is ⊥ perfect cleavage, Y // elongation. Optically –, 2V moderate, $\rho < v$ (moderate). The indices of refraction vary somewhat.

$\alpha = 1.820 \pm 0.005$. $\beta = 1.86 \pm 0.01$. $\gamma = 1.88 \pm 0.01$.

In the liquids that have a high index of refraction, such as methylene iodide, in which As_2S_3, S, and other substances are dissolved, the erinite decomposes with the evolution of gas and the development of crystals.

ERIONITE.

Durkee, Oreg. (U. S. Geol. Survey). Wool-like fibers. Optically +.

$\alpha = 1.438 \pm 0.003$. $\gamma = 1.452 \pm 0.003$.

ERYTHRITE.

Schneeberg, Saxony (U. S. N. M. 82265). Optically +, 2V very large, X normal to the plates, angle of Z to elongation 30° + 1°, pleochroic, absorption Z > Y and X.

$\alpha = 1.629 \pm 0.003$; pale pinkish. $\beta = 1.663 \pm 0.003$; pale violet.
$\gamma = 1.701 \pm 0.003$; red.

ESCHYNITE.

1. Ilmen Mountains, Siberia (U. S. N. M. 78415). Black in mass. In powder, conchoidal grains, reddish brown and perceptibly isotropic.

$n = 2.26 \pm 0.01$.

2. Hitterö, Norway (U. S. N. M.). Reddish brown in powder and sensibly isotropic.

$$n = 2.205 \pm 0.01.$$

ETTRINGITE.

Ettringer, Prussia (U. S. N. M. 85109). Very minute fibers with negative elongation. Very unsatisfactory.

$$n = 1.49 \pm 0.01.$$

Birefringence 0.01 ±.

EUCHROITE.

1. Libethen, Hungary (U. S. N. M.). Emerald-green crystals. Optically +, $2E = 51° \pm 1°$, $2V = 29° \pm 1°$ (measured), $\rho > v$ (moderate).

$$\alpha = 1.695 \pm 0.003. \qquad \beta = 1.698 \pm 0.003. \qquad \gamma = 1.733 \pm 0.003.$$

Bright bluish green in section and faintly pleochroic or nonpleochroic.

2. Utah (U. of C.). Optically +, $2V = 62° \pm 5°$ (indices), $\rho < v$ (strong). Fragments are elongated parallel to Z and tend to lie on a face or cleavage normal to Y. Probably the mineral has a rather perfect cleavage in the prismatic zone. Pleochroic.

$\alpha = 1.723 \pm 0.003$; rather pale yellowish green.
$\beta = 1.738 \pm 0.003$; bluish green.
$\gamma = 1.781 \pm 0.003$; bluish green.

This mineral does not agree with the euchroite from Libethen. Compare with Antlerite.

EUCRYPTITE.

Branchville, Conn. (U. S. N. M. 82522). Probably uniaxial −.

$$\omega = 1.54 \pm 0.01.$$

Birefringence rather low. Not very satisfactory.

EULYTITE.

Schneeberg, Saxony (U. S. N. M. 85192).

$$n = 2.05 \pm 0.01.$$

Birefringence very low.

EUXENITE.

Hitterö, Norway (U. S. N. M. 49001). In section reddish brown and perceptibly isotropic.

$$n = 2.24 \pm 0.02.$$

FAIRFIELDITE.

Branchville, Conn. (W. T. Schaller). Optically +, 2V very large, $\rho > v$ (moderate).

$\alpha = 1.636 \pm 0.003$. $\beta = 1.644 \pm 0.003$. $\gamma = 1.654 \pm 0.003$.

FARATSIHITE.

Faratsihi, Madagascar (Prof. Lacroix). Pale-yellow compact mass. Under the microscope it is seen to be made up of minute fibers that have + elongation. Optic properties vary a little.

$\beta = 1.560 \pm 0.01$.

Birefringence about 0.02.

Part of the material is submicroscopic in crystallization and has a somewhat lower index of refraction.

FELSOEBANYITE.

Felsöbânya, Hungary (Col. Roebling). Broad, rectangular laths. Optically +, $2E = 77° \pm 3°$, $2V = 48° \pm 2°$ (measured), $\rho > v$ (perceptible). Z is normal to the flat face and X is parallel to the elongation.

$\alpha = 1.516 \pm 0.003$ $\beta = 1.518 \pm 0.003$. $\gamma = 1.533 \pm 0.005$.

FERBERITE.

See Wolframite (p.157).

FERGUSONITE.

Baringer Hill, Tex. (F. L. Hess). Brown in section and perceptibly isotropic.

$n = 2.19 \pm 0.02$.

FERNANDINITE.

Type, Minasragra, Peru (W. T. Schaller). An aggregate of very minute, strongly birefracting fibers. Nearly opaque, and data are very unsatisfactory.

$n =$ about 2.05.

FERRITUNGSTITE.

Germania mine, Deer Trail district, Wash. (U. S. N. M. 86985, type material). Yellow powder. Minute fibers show + elongation. Probably uniaxial −.

$\omega = 1.80$. $\epsilon = 1.72$.

FERROCOLUMBITE.

See Columbite (p. 60).

FIBROFERRITE.

1. Cimarron, Colo. (F. L. Hess). Fibers have Z parallel to the elongation, feebly pleochroic.

$\alpha = 1.525 \pm 0.003$; nearly colorless. $\gamma = 1.565 \pm 0.003$; pale yellow.

Probably optically + with small axial angle.

2. Genette Mountain, Ariz. (U. of C.). Nearly or quite uniaxial and optically +. Fibers have positive elongation. Faintly pleochroic.

$\alpha = 1.533 \pm 0.003$. $\beta = 1.534 \pm 0.005$. $\gamma = 1.575 \pm 0.003$.

FILLOWITE.

Branchville, Conn. (W. T. Schaller). Optically +, 2V moderate, $\rho < v$ (strong?).

$\alpha = 1.672 \pm 0.003$. $\beta = 1.672 \pm 0.003$. $\gamma = 1.676 \pm 0.003$.

FISCHERITE.

Two specimens labeled "Fischerite" were examined, but probably neither is fischerite.

1. Roman-Gladna, Hungary (A. M. N. H.). Perceptibly isotropic, colloidal crusts that have somewhat variable indices of refraction.

$n = 1.51 \pm 0.02$.

Compare with Planerite (p. 173) and Evansite (p. 172).

2. Roman-Gladna, Hungary (Yale). White enamel, opal-like. In section the mineral is made up of layers of minute fibers that show + elongation and nearly or quite parallel extinction. Different layers differ somewhat.

$n = 1.47 \pm 0.01$.

Birefringence moderate.

See Vashegyite (p. 279).

FLINKITE.

Harstig mine, Pajsberg, Sweden (Col. Roebling). Minute dark-greenish prismatic crystals. In section not deeply colored and not strongly pleochroic. Optically +, 2V large, $\rho > v$ (perceptible).

$\alpha = 1.783 \pm 0.003$; pale brownish green. $\beta = 1.801 \pm 0.003$; yellowish green. $\gamma = 1.834 \pm 0.003$; orange-brown.

FLORENCITE.

Minas Geraes, Brazil (Col. Roebling). Light-brown crystal grains. Uniaxial +.

$$\omega = 1.680 \pm 0.01.$$

Birefringence about 0.005.

FLUELLITE.

Stenna Gwyn, Cornwall, England (A. M. N. H.). Clear crystals coating quartz. Optically +, 2V = 85° ± (indices), $\rho < v$ (rather strong).

$$\alpha = 1.473 \pm 0.003. \qquad \beta = 1.490 \pm 0.003. \qquad \gamma = 1.511 \pm 0.003.$$

FLUOCERITE.

Österby, Sweden (Yale, B. Coll. 4424). Optically +, uniaxial.

$$\beta = 1.615 \pm 0.003.$$

Birefringence about 0.002. The mineral is filled with inclusions which have a strong birefringence.

FORSTERITE.

Nepheline basalt from Idaho. Analyses of the rock indicate a nearly pure magnesian olivine. Optically +, 2V = 90° ± 5° (indices), dispersion slight.

$$\alpha = 1.640 \pm 0.003. \qquad \beta = 1.660 \pm 0.003. \qquad \gamma = 1.680 \pm 0.003.$$

FRANKLINITE.

Franklin Furnace, N. J. (U. of C.). Isotropic. Reddish brown in section.

$$n_{\mathrm{Li}} = 2.36 \pm 0.02.$$

FREMONTITE.

1. Near Canon City, Colo. (type material from W. T. Schaller). Optically +, 2V very large. Polysynthetic twinning, with symmetrical extinction on cleavage piece, angle of Z to lamellae = 29°.

$$\alpha = 1.594 \pm 0.003. \qquad \beta = 1.603 \pm 0.003. \qquad \gamma = 1.615 \pm 0.003.$$

2. Austria (W. T. Schaller). 2V nearly 90° and optical character uncertain.

$$\gamma = 1.618 \pm 0.003.$$

Birefringence rather strong.

FRIEDELITE.

1. Taylor mine, Franklin Furnace, N. J. (Col. Roebling). Optically −, 2V small.

$$\beta = 1.65 \pm 0.01.$$

Birefringence about 0.03.

2. Pajsberg, Sweden (A. M. N. H.). Rose-red tabular crystals. Uniaxial −, ϵ normal to perfect cleavage. Nearly colorless in section.

$$\omega = 1.664 \pm 0.003. \qquad \epsilon = 1.629 \pm 0.003.$$

FUCHSITE.

Washington, Ga. (U. S. N. M. 18886). Variety pagodite. Optically −, 2V moderate, $\rho > \upsilon$ (rather strong), nearly colorless in section.

$$\beta = 1.595 \pm 0.003.$$

Birefringence as in Muscovite (p. 252).

GADOLINITE.

1. Hackberry, Ariz. (F. L. Hess). Pale green in section and nonpleochroic. Specific gravity, 4.32. Optically +, 2V moderately large.

$$\alpha = 1.780 \pm 0.003. \qquad \gamma = 1.785 \pm 0.003.$$

2. Baringer Hill, Tex. (F. L. Hess). Pale green in section and isotropic. Specific gravity, 4.3.

$$n = 1.780 \pm 0.003.$$

3. Devils Head mine, Douglas County, Colo. (analyzed, Eakins) (U. S. N. M.). In section pale greenish. Isotropic. Specific gravity, 4.6.

$$n = 1.783 \pm 0.003.$$

4. Kårarfvet, Sweden (U. S. G. S.). Pale green in section and nonpleochroic. Optically +, 2V moderate, $\rho < \upsilon$ (rather strong). Specific gravity, 4.0.

$$\alpha = 1.772 \pm 0.003. \qquad \gamma = 1.777 \pm 0.003.$$

5. Hooking Hollow, Tex. (F. L. Hess). Dark olive-buff in section. Isotropic. Specific gravity, 3.6.

$$n = 1.710 \pm 0.003.$$

This is probably not gadolinite. Compare with Rowlandite (p. 129).

6. Baringer Hill, Tex. (F. L. Hess). Dark olive-buff in section. Isotropic.

$$n = 1.710 \pm 0.003.$$

Almost identical with specimen No. 5.

GAGEITE.

Franklin Furnace, N. J. (Col. Roebling). Minute, colorless needles or laths. Optically −, 2V moderate, $\rho < v$ (extreme), Z is parallel to the fibers. Lying on the chief crystal face laths show the emergence of X on the edge of the field. The face is probably {110}. The mineral appears to be orthorhombic.

$\alpha = 1.723 \pm 0.003$. $\beta = 1.734 \pm 0.003$. $\gamma = 1.736 \pm 0.003$.

GANOMALITE.

Jacobsberg, Sweden (N. M. N. H., Stockholm). Pale yellowish, waxy grains. Uniaxial +.

$\omega = 1.910 \pm 0.005$. $\epsilon = 1.945 \pm 0.005$.

GEARKSUTITE.

Ivigtut, Greenland (A. M. N. H.). White, chalky. Optically −, 2V moderate. Minute fibers or prisms. X is normal to the fibers, Y makes a large angle with the fibers. The mineral is probably monoclinic, with $X = b$ and the angle of Y to the elongation large.

$\alpha = 1.448 \pm 0.003$. $\beta = 1.454 \pm 0.003$. $\gamma = 1.456 \pm 0.003$.

GEIKIELITE.

Ceylon (Col. Roebling). Uniaxial −. In section rather faintly pleochroic in red-brown, with absorption $\epsilon > \omega$.

$\omega = 2.31 \pm 0.02$. $\epsilon = 1.95 \pm 0.01$.

GIBBSITE.

1. Dundas, Tasmania (U. S. N. M. 84868). White, fluffy coating. Imperfect plates and fibers, which show a highly perfect cleavage and Z emerging from the plates. Optically +, 2V very small.

α and $\beta = 1.565 \pm 0.010$.

Birefringence 0.03 ±.

2. District of Kussihsk, Urals (U. S. N. M.). Similar to No. 1.

α and $\beta = 1.565 \pm 0.003$. $\gamma = 1.58 \pm 0.01$.

3. Zlatoust, Siberia (U. S. N. M.). Similar to No. 1.

α and $\beta = 1.572 \pm 0.005$.

Birefringence moderate.

4. Richmond, Mass. (U. S. N. M.). White enamel-like stalactites. Rather coarse fibers, with a perfect cleavage along the fibers. Z is

inclined at a considerable angle to the normal to the fibers. Optically +, 2V very small. Some zonal growths.

α and $\beta = 1.567 \pm 0.003$. $\gamma = 1.589 \pm 0.003$.

5. Chester, Mass. (U. S. N. M.). Similar to No. 4. Optically +, 2V ranges from rather small to 0. Zonal banding has somewhat different optical properties.

α and $\beta = 1.566 \pm 0.003$. $\gamma = 1.585 \pm 0.003$.

GILPINITE.

1. Gilpin County, Colo. (U. S. N. M.). Labeled "Uranopilite." Minute greenish-yellow lath-shaped crystals. Optically −, 2V near 90°, $\rho > v$ (very strong); in small part optically +, $\rho < v$ (very strong). Laths normal to X show polysynthetic twinning with composition plane normal to the flat face and parallel to the elongation. These laths show symmetrical extinction with the angle of Y to the lamellae 5½°. Faintly pleochroic.

$\alpha = 1.577 \pm 0.003$; colorless. $\beta = 1.596 \pm 0.003$; nearly colorless. $\gamma = 1.616 \pm 0.003$; pale yellowish.

2. Colorado (A. M. N. H.). Labeled "Uranopilite." Minute, greenish-yellow, lath-shaped crystals. Optically −, $2V = 86° \pm 3°$ (indices). X is normal to the laths; $Y \wedge$ elongation, 8°; dispersion of bisectrices rather strong. Faintly pleochroic.

$\alpha = 1.575 \pm 0.003$; colorless. $\beta = 1.594 \pm 0.003$. $\gamma = 1.611 \pm 0.003$; canary-yellow.

3. Central City, Colo. (Cal. Min.). Labeled "Johannite." Minute greenish-yellow lath-shaped crystals. Optically +, 2V near 90°. $\rho < v$ (very strong). X is normal to the laths. The laths show polysynthetic twinning parallel to the elongation and extinction Y to elongation 5½°. When turned on edge the laths show parallel extinction. Pleochroic.

$\alpha = 1.577 \pm 0.003$; practically colorless. $\beta = 1.597 \pm 0.003$; very pale greenish yellow. $\gamma = 1.616 \pm 0.003$; pale greenish yellow.

4. Cornwall, England (Col. Roebling). Labeled "Uranoker" or "Uranopilite." Yellow coatings of minute crystals which have much gypsum mixed with them. The laths show polysynthetic twinning, and the composition plane is normal to the flat face and parallel to the length. The extinction is symmetrical and $Y \wedge$ elongation = 5°. X is sensibly normal to the laths. Some crystals,

probably turned on end, are rhombic in outline with Z parallel to one edge. Optically +, 2V large, $\rho < v$ (strong).

$\alpha = 1.575 \pm 0.003$; nearly colorless. $\beta = 1.592 \pm 0.003$; pale yellow.
$\gamma = 1.612 \pm 0.003$; canary-yellow.

Evidently the four specimens are identical. The mineral is monoclinic and occurs in lath-shaped crystals (010), elongated along *c*. Lamellar twinning (100). $X = b$, $Y \wedge c = 5\frac{1}{2}°$ to 8°.

GLOCKERITE.

Zuchmantel, Silesia (U. of C.). Limonite-like porous crusts. In section clear, red fibers, very minute and intertwined. Optical character not determined.

$\alpha = 1.76 \pm$. $\gamma = 1.81 \pm$.

The properties are somewhat variable, but the average values for the indices of refraction are as stated above.

GOETHITE.

1. No locality (U. of C.). "Limonite." Optically—, 2V moderate, $\rho > v$ (very strong). Elongation of fibers is +.

$\alpha = 2.18 \pm 0.01$. $\beta = 2.28 \pm 0.01$. $\gamma = 2.31 \pm 0.01$.

2. Antwerp, N. Y. (U. of C.). "Limonite." Radiating fibers. Optically—, 2V moderate, $\rho > v$ (very strong). Y normal to cleavage and Z parallel to elongation. Absorption rather strong in yellow, $Y > Z > X$.

$\alpha = 2.19 \pm 0.01$. $\beta = 2.31 \pm 0.01$. $\gamma = 2.33 \pm 0.01$.

3. Ishpeming, Mich. (U. S. N. M. 44775). Labeled "Xanthosiderite." Pale-yellowish woody fibers. Optically —, 2V large, $\rho > v$ (very strong). The fibers tend to lie on a face normal to Y, Z parallel to elongation. Faintly pleochroic in reddish brown. Absorption Y and $Z > X$.

$\alpha = 2.15 \pm 0.01$. $\gamma = 2.27 \pm 0.01$.

4. Colorado (U. of C.). Optically—, nearly uniaxial, 2V small but variable, $\rho < v$ (extreme). X is normal to the perfect cleavage. Pleochroism moderate in red-brown with absorption $Z > Y > X$. Translucent and not very deeply colored in section.

$\alpha_{Li} = 2.21 \pm 0.01$. β_{Li} and $\gamma_{Li} = 2.35 \pm 0.01$.

5. Thuringia (Harvard). Labeled "Xanthosiderite." Optically—, 2V small, $\rho > v$ (extreme), X is normal to the perfect cleavage; Z

is parallel to the fibers. Moderately pleochroic with absorption $X < Y$ and Z.

$$\alpha_{Li} = 2.21 \pm 0.01. \qquad \beta_{Li} \text{ and } \gamma_{Li} = 2.35 \pm 0.01.$$

GONNARDITE.

Chaux de Bergonne, Puy-de-Dôme, France (W. T. Schaller). Optically +, $2E = 83° \pm 10°$, $2V = 52° \pm 6°$ (measured). Y is parallel to the fibers, which tend to lie on a face normal to X.

$$\alpha = 1.514 \pm 0.005. \qquad \beta = 1.515 \pm 0.005. \qquad \gamma = 1.520 \pm 0.005.$$

The properties are somewhat variable.

GOSLARITE.

1. Goslar, Harz Mountains, Germany (U. S. N. M.). The sample is in a sealed tube, but the mineral is partly altered to a white powder.

A. The fresh center is vitreous and has the following optical properties. 2V very near 0.

$$\alpha = 1.450 \pm 0.003. \qquad \beta \text{ and } \gamma = 1.481 \pm 0.003.$$

B. The white alteration product is very finely crystalline and has a moderate birefringence and a mean index of refraction of 1.570 ± 0.005.

2. Gagnon mine, Butte, Mont. (U. S. N. M. 83637). Although the material has been kept in a sealed tube, it has completely altered to an aggregate of minute fibers that have − elongation, moderate birefringence, and a mean index of refraction of 1.600 ± 0.01.

GRAFTONITE.

Near Grafton, N. H. (U. S. N. M. 85012). Optically +, 2V small, $\rho > v$ (rather strong), clear and colorless in section.

$$\alpha = 1.700 \pm 0.003. \qquad \beta = 1.705 \pm 0.003. \qquad \gamma = 1.724 \pm 0.003.$$

GRIPHITE.

1. Float near Keystone, S. Dak. (F. L. Hess). Qualitative tests show it to be a hydrous phosphate of manganese. Brownish to yellowish in section and isotropic.

$$n = 1.63 \text{ to } 1.65.$$

A little birefracting material.

2. Unknown locality in South Dakota (F. L. Hess). Similar to No. 1. Isotropic.

$$n = 1.65 \text{ variable.}$$

GUARINITE.

Monte Somma, Vesuvius (U. S. N. M. 47065).

A. "Guarinite." Pale-yellow tabular crystals in cavities. Colorless in section. Thick pieces are pleochroic in yellow. Optically—, 2V rather large, $\rho < v$ (rather strong) (?). Z emerges from the cleavage plates. X is sensibly normal to a crystal face.

$\alpha = 1.704 \pm 0.003$. $\beta = 1.716 \pm 0.003$. $\gamma = 1.727 \pm 0.003$.

The crystals just sink in pure methylene iodide. Specific gravity, about 3.31. Guarinite has been shown to be identical with hiortdahlite by Zambonini and Prior, but the above optical data are much nearer to those of wöhlerite.

B. Yellow crystal embedded in the matrix. Either a finely fibrous aggregate or complexly twinned crystals. Optically—, 2V large, $\rho < v$ (?).

$\alpha = 1.653 \pm 0.005$. $\gamma = 1.664 \pm 0.005$.

Floats in methylene iodide. It does not agree closely with any known mineral.

HAIDINGERITE.

Joachimsthal, Bohemia (R. M. Wilke, Palo Alto, Calif.). Minute aggregates of soft, glassy crystals. Optically +, 2E = 102° ± 5°, 2V = 58° ± 3° (measured), 2V = 60° (indices). Dispersion slight. In outline cleavage pieces are commonly acute rhombs with an angle of about 33° between the edges (fig. 8). X is normal to this cleavage and Y bisects the acute angle of the rhombs. There is another cleavage (or crystal face) normal to Z.

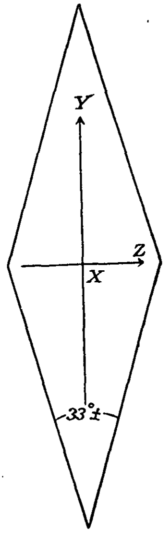

FIGURE 8.—Optical orientation of common cleavage fragments {010} of haidingerite.

$\alpha = 1.590 \pm 0.003$. $\beta = 1.602 \pm 0.003$. $\gamma = 1.638 \pm 0.003$.

HAMLINITE.

Eagle Rock mine, Boulder County, Colo. (F. L. Hess). Uniaxial + but shows anomalous birefringence in hexagonal segments. Has zonal growths.

$\omega = 1.620 \pm 0.005$. $\epsilon = 1.630 \pm 0.005$.

HANCOCKITE.

Franklin Furnace, N. J. (U. S. N. M. 84995). Optically—, 2V large, $\rho > v$ (perceptible). Pleochroism rather strong in reddish brown, absorption Z > X.

$\alpha = 1.788 \pm 0.003$. $\beta = 1.81 \pm 0.01$. $\gamma = 1.830 \pm 0.003$.

HANNAYITE.

Skipton Hochla, Ballarat, Victoria (Col. Roebling). White powder or crust. Contains newberyite, hannayite, and other minerals. Optically −, $2E = 69° \pm 2°$, $2V = 42° \pm 1°$ (measured). Dispersion not perceptible. X is perceptibly normal to the perfect cleavage, and Y makes an angle of about 33° with the fibers. These data indicate a monoclinic mineral with $X = b$ and $Y \wedge c = 33° \pm$.

$\alpha = 1.555 \pm 0.003$. $\beta = 1.572 \pm 0.003$. $\gamma = 1.575 \pm 0.003$.

HATCHETTOLITE.

Mitchell County, N. C. (Col. Roebling). Isotropic and nearly colorless in section. It is filled with birefracting shreds, probably due to partial alteration.

n is variable but averages about 1.98.

HAUERITE.

Raddusa, Sicily (A. M. N. H.). Isotropic and deep red in section. Somewhat paler in color than the selenium melt.

$n_{Li} = 2.69 \pm 0.01$.

HAUSMANNITE.

Plumas County, Calif. (U. of C.). Reddish brown in section and nonpleochroic. Uniaxial −, tend to lie on a cleavage normal to the optic axis.

$\omega_{Li} = 2.46$. $\epsilon_{Li} = 2.15$.

HEMAFIBRITE.

Nordmark, Sweden (Col. Roebling). Optically +, 2V moderate. Red-brown in section and nonpleochroic.

$\alpha = 1.87 \pm 0.01$. $\beta = 1.88 \pm 0.01$. $\gamma = 1.93 \pm 0.01$.

HEMATOLITE.

Nordmark, Sweden (A. M. N. H.). "Diadelphite." Brownish-red crystals with perfect cleavage. Optically −, 2V = small, the hyperbolas of the interference figure open slightly. Colorless to brownish red in section and nonpleochroic.

$\omega = 1.733 \pm 0.003$. $\epsilon = 1.714 \pm 0.003$.

HERCYNITE AND PLEONASTE.

1. Rogers mine, Poughkeepsie, N. Y. (U. S. N. M. 50520). Hercynite. Black in mass. In section grass-green and filled with inclusions of magnetite (?). Isotropic.

$n = 1.800 \pm 0.005$.

2. Virginia. Hercynite (or pleonaste, as it contains considerable MgO). Characters similar to those of No. 1.

$$n = 1.785 \pm 0.005.$$

3. Peekskill, N. Y. Pleonaste. Material analyzed by G. S. Rogers.[27] Contains Al_2O_3, 65.02; FeO, 20.28; MgO, 13.70. Characters similar to those of Nos. 1 and 2.

$$n = 1.775 \pm 0.005.$$

The refractive index commonly given for hercynite, $n = 1.749$ (Lévy-Lacroix), is no doubt too low.

HERRENGRUNDITE.

Herrengrund, Hungary (U. S. N. M. 84659). Optically −, $2E = 68° \pm 3°$, $2V = 39° \pm 2°$ (measured), $\rho < v$ (marked). X is nearly normal to the cleavage. Pleochroism strong.

$\alpha = 1.585 \pm 0.003$; very pale green. $\beta = 1.649 \pm 0.003$: Venice green. $\gamma = 1.660 \pm 0.003$; turquoise green.

HETAEROLITE.

1. Franklin, N. J. (A. M. N. H.). Uniaxial −, tend to lie on basal cleavage, pleochroism faint in red-brown, absorption $\epsilon > \omega$.

$$\omega = 2.34 \pm 0.02. \qquad \epsilon = 2.14 \pm 0.02.$$

Palache gives composition of this mineral as $ZnO.Mn_2O_3$. Specific gravity, 4.85.

2. Leadville, Colo. (G. F. Loughlin). Nearly black fibers. More nearly opaque than the mineral from New Jersey. Uniaxial or nearly so, optically −, elongation of fibers is +.

$$\omega = 2.26 \pm 0.02. \qquad \epsilon = 2.10 \pm 0.02.$$

The indices of refraction are somewhat variable.

Ford and Bradley give the composition of hetaerolite from this locality as $2ZnO.2Mn_2O_3.H_2O$. Specific gravity, 4.55.

HETEROSITE.

1. La Vilate, France (U. S. N. M. 48622). Optically −, 2V large, variable in properties. Some of the lighter-colored parts have $\beta = 1.84$; some of the darker have β above 1.87. Birefringence 0.03 ±.

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[27] New York Acad. Sci. Annals, vol. 21, p. 69, 1911.

2. Limoges, France (U. of C.). Nearly black in mass, dark red in powder, more nearly homogeneous than No. 1. Optically $-$, 2V large; lies on a cleavage normal to $Bx_a = X$. Strongly pleochroic.

$\alpha = 1.86 \pm 0.01$; greenish gray. $\beta = 1.89 \pm 0.01$; deep red (hematite red). $\gamma = 1.91 \pm 0.01$; dark red.

HIBBENITE.

Salmo, B. C. Type from Prof. Phillips. Optically $-$, $2E = 92° \pm 2°$, $2V = 54° \pm 1°$ (measured), $\rho < \upsilon$ (perceptible).

$\alpha = 1.582 \pm 0.003$. $\beta = 1.592 \pm 0.003$. $\gamma = 1.593 \pm 0.003$.

X is normal to the most perfect cleavage and Y is parallel to the two cleavages. Compare with Hopeite (p. 87) and Spencerite (p. 135).

HIELMITE.

1. Fin Creek, Sweden (A. M. N. H). Optically $+$, 2V probably small. Nearly opaque, very strongly pleochroic.

$\alpha_{Li} = 2.30 \pm 0.02$; yellowish brown. $\gamma_{Li} = 2.40 \pm 0.03$; nearly opaque.

2. Kårarfvet mine, Sweden (U. S. N. M. 14439). Nearly or quite uniaxial, optically $+$, strongly pleochroic.

$\omega_{Li} = 2.30 \pm 0.01$; yellowish brown. $\epsilon_{Li} = 2.40 \pm 0.04$; nearly opaque.

HIGGENSITE.

Bisbee, Ariz. Optically —, 2V near 90°, $\rho > \upsilon$ rather strong.

$\alpha = 1.800 \pm 0.005$. $\beta = 1.831 \pm 0.005$. $\gamma = 1.846 \pm 0.005$.

HISINGERITE.

Riddarhyttan, Sweden (U. S. N. M. 48995). Amorphous and in section the color is zinc-orange.

n ranges from 1.49 to 1.53; averages about 1.51,

HODGKINSONITE.

Franklin, N. J. (original material from W. T. Schaller). Optically $-$, 2V moderate, $\rho > \upsilon$ (rather strong). X makes a large angle with the normal to the cleavage.

$\alpha = 1.715 \pm 0.003$. $\beta = 1.735 \pm 0.003$. $\gamma = 1.75 \pm 0.01$.

HOERNESITE.

1. Joachimsthal, Bohemia (A. M. N. H.). White crusts. Fibers similar to No. 2. Optically +, $2V = 60° \pm 5°$ (indices). X is normal to the fibers and Z makes an angle of about 31° to the elongation. The fibers tend to lie on face or cleavage normal to X {010} and appear to be monoclinic, with $X = b$, $Z \wedge$ elongation $= 31°$.

$\alpha = 1.563 \pm 0.003$. $\beta = 1.571 \pm 0.003$. $\gamma = 1.596 \pm 0.003$.

2. A specimen labeled Banat, Hungary (Col. Roebling), differs considerably from the specimen described above and is uncertain. Crystals altered to white chalky aggregate of fibers. Optically +, 2V rather large.

$\alpha = 1.548 \pm 0.003$. $\beta = 1.556 \pm 0.003$. $\gamma = 1.574 \pm 0.003$.

HOMILITE.

1. Arnö, Norway (U. S. N. M. 47031). Isotropic.

$n = 1.640 \pm 0.005$.

2. Langesund, Norway (Brögger, U. of Stockholm).

A. Fresh center. Optically +, 2V large, $\rho > v$ (rather strong), dispersion of bisectrix perceptible. Pleochroic.

$\alpha = 1.715 \pm 0.003$; bluish green. $\beta = 1.725 \pm 0.003$; pale brownish gray. $\gamma = 1.738 \pm 0.003$; pale smoky gray.

B. The altered border has variable optical properties. In thin section it is yellow. The following data for different fragments show the range:

(*a*) Optically +, 2V small, $\rho > v$ (very strong). Birefringence about 0.02.

$\beta = 1.665 \pm 0.003$.

(*b*) Optically +, 2V very small, $\rho > v$ (very strong). Birefringence about 0.02.

$\beta = 1.660 \pm 0.003$.

(*c*) Optically +, $2V = 0$. Dispersion very strong. Birefringence about 0.02.

$\beta = 1.655 \pm 0.005$.

(*d*) Optically +, $2E = 78° \pm 5°$, $2V = 45° \pm 3°$, $\rho < v$ (very strong). Birefringence about 0.02.

$\beta = 1.650 \pm 0.005$.

(*e*) Optically +, $2E = 76° \pm 5°$, $2V = 44° \pm 3°$, $\rho < v$ (very strong). Birefringence about 0:02.

$\beta = 1.630 \pm 0.005$.

HOPEITE.

Broken Hill, Rhodesia (U. S. N. M. 92957). The crystals show the usual zonal structure. Optically −, 2E ranges from 0 to 67°. $\rho < v$ (perceptible).

$$\alpha = 1.574 \pm 0.003 \text{ for all the fragments.}$$

Most of the material has a small axial angle, with β and $\gamma = 1.582 \pm 0.003$. Some few grains with a larger axial angle show a higher value for β and γ, probably about 1.59.

X is normal to one perfect cleavage and Y or Z to the other. Perhaps this arrangement is due to zonal growths of somewhat variable composition rather than to an intergrowth of two distinct minerals.

HOWLITE.

1. Windsor, Nova Scotia (U.S.N.M. 47606). Optically −, 2V large, dispersion not noticed. In tabular elongated crystals with pointed end. Crystals that lie on the flat face show parallel extinction with X across the length, and Z makes a large angle with the normal to the plates. There is a long thin face perceptibly normal to X, and crystals lying on this face give a large extinction angle, with $Z \wedge$ elongation about 44°. The mineral is probably monoclinic, tabular {100} or {001}, with a thin face {010}. $X = b$, $Z \wedge c$ (?) $= 44° \pm$.

$$\alpha = 1.586 \pm 0.003. \qquad \beta = 1.598 \pm 0.003. \qquad \gamma = 1.605 \pm 0.003.$$

2. Ryan, Calif. Micaceous white mass. 2V very large, probably optically −. Y or Z makes a large angle to the normal to the plates. Plates turned on an edge to give parallel extinction show X along the plates.

$$\alpha = 1.583 \pm 0.005. \qquad \beta = 1.596 \pm 0.005. \qquad \gamma = 1.605 \pm 0.005.$$

Probably monoclinic tabular {100} or {001}. $X = b$.

HUEBNERITE.

See Wolframite (p. 157).

HUEGELITE.

Geroldseck, Baden, Germany (Col. Roebling). Yellow needles in mass, tablets and laths in powder. Z is nearly or quite normal to the flat face; interference color on this section is abnormal green, and the extinction in white light is sharp and perceptibly parallel. Other sections show no extinction in white light but give abnormal interference colors. Optically +, dispersion extreme; for red light 2V is small and the optic plane is parallel to the length, whereas for blue the axial angle is large and is across the length.

$$\beta = 1.915 \pm 0.005.$$

Birefringence rather weak.

HUMITE.

Monte Somma, Italy. Optically +, 2V medium large.

$\alpha = 1.617 \pm 0.005.$ $\beta = 1.624 \pm 0.005.$ $\gamma = 1.652 \pm 0.005.$

HUREAULITE.

Branchville, Conn. (W. T. Schaller). Optically −, 2V large, $\rho < v$ (very strong).

$\alpha = 1.647 \pm 0.003.$ $\beta = 1.654 \pm 0.003.$ $\gamma = 1.660 \pm 0.003.$

HYALOTEKITE.

1. Långban, Sweden (Col. Roebling). 2V very small, optically +.

α and $\beta = 1.960 \pm 0.005.$ $\gamma = 1.963 \pm 0.005.$

2. Långban, Sweden (A. M. N. H.). Optically +, $2E = 53° \pm$, $2V = 26° \pm$ (variable) (measured), $\rho < v$ (strong).

$\alpha = 1.965 \pm 0.003.$ $\beta = 1.965 \pm 0.003.$ $\gamma = 1.969 \pm 0.003.$

HYDROBORACITE.

1. Stassfurt, Germany (A. M. N. H.). White, chalky mass. Very minute fibers.

$$\beta = 1.626 \pm 0.005.$$

Birefringence 0.01, approximately.

Not hydroboracite.

2. Ryan, Calif. Determined as hydroboracite by W. T. Schaller. Acicular aggregates. Two very perfect cleavages parallel to length. Plates parallel to one cleavage show parallel extinction and Y across the length; plates parallel to the other cleavage are sensibly normal to Y and give an extinction angle X to length of 31°. Optically +, 2V rather large, $\rho < v$ (perceptible).

$\alpha = 1.517$ $\beta = 1.534$ $\gamma = 1.565.$

Probably monoclinic, elongated, parallel to c, and with very perfect cleavages (100) and (010). $Y = b$, $X \wedge c = 31°$.

HYDROGIOBERTITE.

1. Philips Springs, Napa County, Calif. (analyzed by R. C. Wells, of U. S. Geol. Survey). Clearly not homogeneous. Successive layers of very minute fibers with some quartz, etc. The material consists chiefly of two fibrous minerals.

A. This mineral gives parallel extinction and positive elongation.

$$\alpha = 1.52 \pm 0.01.$$

Birefringence not strong.

B. This mineral has a much lower index of refraction and much higher birefringence. The two minerals, A and B, occur in part in separate layers, in part mixed together.

2. Philips Springs, Napa County, Calif. (U. S. N. M. 86673). Not homogeneous. The material consists chiefly of mineral A, but probably some of it is amorphous. Very minutely crystalline.

A. Optically +, 2V moderate. Y is normal to the fibers and $X \wedge$ fibers about 20° (?).

$$n = \text{about } 1.52.$$

Birefringence moderate. Probably hydromagnesite.

3. Monte Somma, Italy (Col. Roebling). Not homogeneous. Very finely crystalline material. Chiefly mineral A; some B.

A. In this mineral $\alpha = 1.52 \pm 0.01$ and $\gamma = 1.54 \pm 0.01$. Elongation is + in some crystals and − in others. Probably hydromagnesite.

B. This mineral has a higher value for n and a lower birefringence.

Hydrogiobertite is probably not homogeneous but is an impure hydromagnesite.

HYDROMAGNESITE.

San Benito County, Calif. (analyzed by R. C. Wells, of U. S. Geol. Survey). Minute fibers. Optically +, 2V moderate. Y parallel to fibers.

$$\alpha = 1.527 \pm 0.003. \qquad \beta = 1.530 \pm 0.003. \qquad \gamma = 1.540 \pm 0.003.$$

HYDROPHILITE.

Artificial mineral made by fusing $CaCl_2 + H_2O$.

1. Solidified melt, crushed quickly while hot and immersed in oil. Uniaxial +.

$$\omega = 1.605 \pm 0.005. \qquad \epsilon = 1.615 \pm 0.005.$$

It shows a very perfect prismatic cleavage and polysynthetic twinning parallel to the c axis.

2. This material inverts while in the oil to an isotropic form, in which $n = 1.52 \pm 0.01$, and this material is filled with and bordered by a birefracting material in shreds that has a lower index of refraction.

HYDROTALCITE.

1. Snarum, Norway (U. of C.). Basal plates and fibers. Basal cleavage micaceous. Uniaxial −.

$\omega = 1.516 \pm 0.003$. $\epsilon = 1.504 \pm 0.003$.

2. Kongsberg, Norway (U. S. N. M. 13191). Characters as in No. 1. Uniaxial −.

$\omega = 1.510 \pm 0.003$. $\epsilon = 1.495 \pm 0.003$.

3. St. Lawrence County, N. Y. (U. S. N. M. 50578). Uniaxial −.

$\omega = 1.511 \pm 0.003$. $\epsilon = 1.496 \pm 0.003$.

4. England. Voelknerite, houghite. Uniaxial −.

$\omega = 1.553 \pm 0.003$. $\epsilon = 1.544 \pm 0.003$.

This mineral is probably another member of the hydrotalcite group.

HYDROZINCITE.

1. Bou-Thaleb mine, Constantine, Algeria (U. S. N. M. 84879). Rather coarse plates and fibers. Optically −, 2V = 40° ± 2° (indices), $\rho < v$ (rather strong). Y is nearly normal to the laths and Z is parallel to the length. Sections normal to X show a considerable extinction angle.

$\alpha = 1.640 \pm 0.003$. $\beta = 1.736 \pm 0.003$. $\gamma = 1.750 \pm 0.003$.

Probably monoclinic in laths parallel to {100} or {001} and elongated along *c* or *a*. Perfect cleavage parallel to the flat face. X = *b*, $Z \wedge c$ (or *a*) = moderate.

2. Malfidano, Sardinia (A. M. N. H.). Very minute fibers, with + elongation, rarely with − elongation. Too minute for satisfactory data.

$\alpha = 1.65$. $\gamma = 1.73$.

3. May Day mine, Tintic, Utah (G. F. Loughlin). Very minute fibers, too minute for satisfactory study. Optically −, 2V small, elongation −.

$\alpha = 1.63 \pm 0.02$. $\gamma = 1.73 \pm 0.02$.

IDDINGSITE.

1. Pyroxene latite, Wicher Mountain Knoll, Pikes Peak quadrangle, Colo. (U. S. Geol. Survey, P. R. C. 1325). Reddish-brown grains. Optically −, 2V large, $\rho < v$ (strong). X is normal to the plates

and the axial plane is across a fibrous structure. The indices vary somewhat.

$\alpha = 1.71 \pm 0.01$. $\beta = 1.74 \pm 0.01$. $\gamma = 1.76 \pm 0.01$.

2. Basalt, Santa Monica Mountains, Calif. Similar to No. 1. Optical properties vary a little.

$\beta = 1.75 \pm 0.01$.

Birefringence about 0.05.

3. Uncompahgre quadrangle, Colo. (U. S. Geol. Survey, U. P. 17). In thin section clear, pale reddish brown. Optical properties vary a little. Optically +, 2V large, $\rho > \upsilon$ (strong). Faintly pleochroic.

$\alpha = 1.70 \pm 0.01$. $\beta = 1.72 \pm 0.01$. $\gamma = 1.74 \pm 0.01$.

4. Carmelo Bay, Calif. Carmelolite. Original occurrence. The usual reddish-brown grains with a lamellar structure. Optically −, 2V nearly 90°, $\rho < \upsilon$ (strong).

$\beta = 1.74 \pm 0.01$.

Varies a little. Birefringence strong.

These data indicate that iddingsite is a definite mineral and that it is probably not related to serpentine.

ILVAITE.

1. Elba (U. of C.). Optically −, 2V small, $\rho < \upsilon$ (very strong). Intensely pleochroic. X and Y = dark greenish, nearly opaque. Z = pale yellowish brown.

$\gamma = 1.91 \pm 0.01$.

Birefringence strong.

2. Japan (U. S. N. M.). Too deeply colored for good optical data. Probably optically −, 2V small, strong dispersion. Pleochroism as in No. 1.

$\gamma = 1.92 \pm 0.01$.

Birefringence strong.

Other specimens from Japan and Elba gave no better data.

INESITE.

Harstig mine, Pajsberg, Sweden (U. S. N. M. 51648). Optically −. 2V = 56° ± 10° (indices). Sections parallel to the most perfect cleavage are nearly normal to Bx_a and show Z′ to elongation and cross cleavage about 60°. Cleavage section showing emergence of Bx_o on the edge of the field show Y′ to the elongation and cleavage about 10°.

$\alpha = 1.609 \pm 0.003$. $\beta = 1.636 \pm 0.003$. $\gamma = 1.644 \pm 0.003$.

Hence, extinction on {010} ($Z' \wedge c$) = 60° ±, X makes an angle of about 10° with the normal to {010}.

INYOITE.

Inyo County, Calif. (Type, W. T. Schaller). Optically −, 2E = 118° ± 5°, 2V = 70° ± 3° (measured), $\rho < v$ (slight). Y = *b*, X oblique to *c*.

$\alpha = 1.495 \pm 0.003$. $\beta = 1.51 \pm 0.01$. $\gamma = 1.520 \pm 0.003$.

IODYRITE.

Old Man mine, Silver City, N. Mex. (U. S. N. M. 48705). Optically +, bars open slightly. Lie on base. Abnormal green interference colors.

$\omega = 2.21$. $\epsilon = 2.22$.

IRON-COPPER CHALCANTHITE.

1. Ducktown, Tenn. (U. S. N. M.). Labeled "Pisanite." Optically −, 2E = 98° ± 5°, 2V = 60° ± 5° (measured), dispersion not noticed.

$\alpha = 1.513 \pm 0.005$. $\beta = 1.526 \pm$ (computed). $\gamma = 1.534 \pm 0.005$.

2. Bingham, Utah (U. S. N. M., analyzed). Labeled "Pisanite." In section pale, bluish-green fibers.

$\alpha = 1.515 \pm 0.005$. $\gamma = 1.536 \pm 0.005$.

3. Dehydration of artificial pisanite, CuO:FeO = 1:1. Finely fibrous. Optically −, 2V moderate, $\rho > v$ (slight?).

$\alpha = 1.517 \pm 0.003$. $\beta = 1.536 \pm 0.003$. $\gamma = 1.543 \pm 0.003$.

ISOCLASITE.

Joachimsthal (Col. Roebling). White, cotton-like fibers. Minute prisms. Optically +, angle of Z to elongation small. Section shows parallel extinction normal to X; hence monoclinic, and X = *b*.

$\alpha = 1.565 \pm 0.003$. $\beta = 1.568 \pm 0.003$. $\gamma = 1.580 \pm 0.003$.

JAROSITE.

1. Tintic, Utah, Mammoth mine (Col. Roebling). Reddish-brown cubical crystals. Optically −, 2V very small. No good cleavage. Pleochroism perceptible. Indices vary somewhat.

$\alpha = 1.715 \pm 0.003$; colorless. $\beta = 1.817 \pm 0.003$; reddish brown.
$\gamma = 1.820 \pm 0.003$; reddish brown.

2. Mâcon, France (U. S. N. M. 48619). "Carphosiderite." Soft, straw-yellow powder the grains of which show minute glistening faces. Scales and fibers not very satisfactory for optical study. Optically –, and perceptibly uniaxial. Plates {001}.

$$\omega=1.81\pm0.01. \qquad \epsilon=1.74\pm0.02.$$

JEFFERISITE.

1. West Chester, Pa. (U. S. N. M.). Jefferisite. Resembles a pale-brown biotite. Perceptibly uniaxial, optically –, optic axis perceptibly normal to the plates.

$$\alpha=1.561\pm0.003.$$

Birefringence about 0.02.

2. Lewis, Pa. (U. S. N. M.). Vermiculite. Resembles a pale-green mica. Optically –, 2V near 0, Bx_a perceptibly normal to plates.

$$\beta \text{ and } \gamma=1.561\pm0.005.$$

Birefringence about 0.02.

3. Delaware County, Pa. (U. S. N. M.). Jefferisite. Resembles a pale-brown biotite. Optically –, 2V very small.

$$\beta \text{ and } \gamma=1.557\pm0.003.$$

Birefringence about 0.02.

4. Corundum Hill, N. C. (U. S. N. M.). Vermiculite. Perceptibly uniaxial, optically –.

$$\omega=1.560\pm0.005.$$

Birefringence about 0.02.

JEFFERSONITE.

1. Franklin Furnace, N. J. (U. S. N. M.). Hillebrand's analysis[28] gives SiO_2, 51.70; Al_2O_3, 0.36; Fe_2O_3, 0.37; MnO, 7.43; ZnO, 3.31; CaO, 23.68; MgO, 12.57; Na_2O, 0.12; H_2O, 0.65. Optically +, 2V medium large, $\rho>\upsilon$ (perceptible).

$$\alpha=1.682\pm0.003. \qquad \beta=1.690\pm0.003. \qquad \gamma=1.710\pm0.003.$$

Optic axis nearly normal to cleavage.

2. Franklin Furnace, N. J. Light-brown crystals. Optically +, 2V medium large.

$$\alpha=1.673\pm0.003. \qquad \beta=1.683\pm0.003. \qquad \gamma=1.702\pm0.003.$$

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[28] Am. Jour. Sci., 4th ser., vol. 7, p. 55, 1899.

3. Franklin Furnace, N. J. Black. Optically +, 2V medium large. Dark green in section.

$\alpha = 1.720 \pm 0.003$. $\beta = 1.731 \pm 0.003$. $\gamma = 1.748 \pm 0.003$.

4. Ogdensburg, N. J. (U. S. N. M. 49651). Optically +, 2V large, $\rho > v$ (slight).

$\alpha = 1.72 \pm 0.01$. $\beta = 1.726 \pm 0.005$. $\gamma = 1.74 \pm 0.01$.

JOHANNITE.

1. Specimens labeled johannite proved to be uranothallite, uranopilite, gilpinite, and other minerals.

2. Wood mine, Gilpin County, Colo. (Col. Roebling). Green powder. Cryptocrystalline, green in powder. Index of refraction variable.

$$n = 1.70 \pm .$$

Birefringence moderate. The data are unsatisfactory, and the mineral is uncertain.

JOHNSTRUPITE.

Brevig, Norway (Col. Roebling). Optically +, 2V large, $\rho > v$ (strong). Polysynthetic twinning and very small extinction angle. A poor cleavage nearly normal to Z.

$\alpha = 1.661 \pm 0.003$. $\beta = 1.666 \pm 0.003$. $\gamma = 1.673 \pm 0.003$.

KAINITE.[29]

Stassfurt, Germany (U. S. N. M.). Colorless mass. Optically −, 2V near 90°, $\rho > v$ (perceptible).

$\alpha = 1.494 \pm 0.003$. $\beta = 1.505 \pm 0.003$. $\gamma = 1.516 \pm 0.003$.

KALINITE AND POTASH ALUM.

Two forms of potash alum occur in nature, the one isotropic and the other fibrous and strongly birefracting. As the isotropic variety corresponds to the artificial potash alum it is recommended that the isotropic mineral be called potash alum and that the fibrous birefracting mineral be called kalinite.

KALINITE.

1. San Bernardino County, Calif. (Col. Roebling). Chiefly mineral A but contains much B.

A. Grains and fibrous aggregates. Optically −, uniaxial or nearly so.

$\omega = 1.456 \pm 0.003$. $\epsilon = 1.429 \pm 0.003$.

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[29] Görgy, R., Min. pet. Mitt., Band 29, pp. 192–210, 1910. The data given by Görgy are not consistent.

Compare with Mendozite (p. 108). This mineral is probably kalinite.

B. Long fibers with large extinction angle. Optically + (?), 2V is small (?), $Z \wedge$ fibers large.

$$\beta = 1.480 \pm 0.005.$$

Birefringence weak. Probably pickeringerite or halotrichite.

2. Mount Wingen, Australia (Prof. Lacroix). Clear, coarse fibers. Optically −, $2E = 79° \pm 1°$, $2V = 52° \pm 1°$ (measured). Dispersion slight.

$$\alpha = 1.430 \pm 0.003. \qquad \beta = 1.452 \pm 0.003. \qquad \gamma = 1.458 \pm 0.003.$$

Fibers lying on a face or cleavage sensibly normal to Z show Y to elongation 13°. Probably monoclinic. See Artificial mendozite (p. —).

POTASH ALUM.

3. Silver Peak district, Esmeralda County, Nev. (U. S. N. M. 15768). Glassy grains. Isotropic.

$$n = 1.453 \pm 0.003.$$

4. Volcano Lake, south of Imperial Valley, Calif. (U. S. N. M.). Isotropic.

$$n = 1.455 \pm 0.003.$$

KALIOPHILITE.

Monte Somma, Italy (Harvard). "Fasellite." Uniaxial −.

$$\omega = 1.537 \pm 0.003. \qquad \epsilon = 1.533 \pm 0.003.$$

KEHOEITE.

Merrit mine, S. Dak. (Col. Roebling). White, chalky powder. Isotropic.

n ranges from about 1.52 to 1.54.

KEILHAUITE.

Langesund, Norway (U. S. N. M. 51286). Optically +, 2V large, $\rho > v$ (strong).

$$\alpha = 1.915 \pm 0.005. \qquad \beta = 1.935 \pm 0.005. \qquad \gamma = 2.03 \pm 0.01.$$

KENTROLITE.

Långban, Sweden (Yale, B. Coll. 4868). Optically +, $2V = 90° \pm$ (indices), $\rho < v$ (strong); pleochroism strong in brownish red. Absorption $Z > Y > X$.

$$\alpha = 2.10 \pm 0.01. \qquad \beta = 2.20 \pm 0.01. \qquad \gamma = 2.31 \pm 0.02.$$

KERMESITE.

Braunsdorf, Germany (U. S. N. M. 12257). Optically +, 2V probably small. Brownish-red needles, clear and translucent, in which Z is perceptibly parallel to the elongation. Birefringence very strong to extreme.

α is a little greater than 2.72. γ is much greater than 2.72.

KLEINITE.

Terlingua, Tex. (type material, W. T. Schaller). Optically −, 2V small to medium, $\rho < v$ (very strong).

$\alpha = 2.16 \pm 0.01$. $\gamma = 2.18 \pm 0.01$.

The uniaxial form is optically +.

$\omega = 2.19 \pm 0.01$. $\epsilon = 2.21 \pm 0.01$.

KNEBELITE.

Dannemora, Sweden (U. S. N. M. 84622). Optically −, 2V = 60° ± (indices), $\rho > v$ (strong).

$\alpha = 1.795 \pm 0.003$. $\beta = 1.831 \pm 0.003$. $\gamma = 1.842 \pm 0.003$.

KNOPITE.

Alnö, Sweden (Col. Roebling). In section brownish and indistinctly, faintly birefracting.

$n = 2.30$.

KNOXVILLITE.

See Copiapite (p. 61).

KOECHLINITE.

Schneeberg, Saxony. Original material (W. T. Schaller). Optically −.

$\beta_{Li} = 2.55$.

Birefringence very strong.

KOETTIGITE.

Schneeberg, Saxony (Col. Roebling). Fibrous, carmine-red coating. Optically +, 2V = 77° ± (indices), $\rho < v$ (rather strong). The crystals tend to lie on a face normal to X. Extinction on this face is not clear in white light, probably owing to strong dispersion of the bisectrix. $Z \wedge$ elongation rather small.

$\alpha = 1.662 \pm 0.003$. $\beta = 1.683 \pm 0.003$. $\gamma = 1.717 \pm 0.003$.

KONINCKITE.

1. Visé, Belgium (A. M. N. H.). Pale yellow in powder. Probably isotropic.

$$n = 1.65 \pm 0.01.$$

Some of the material consists of clouded fibers which have a lower value for n.

2. Richelle, near Visé, Belgium (Col. Roebling). Yellow crust. Chiefly yellow and probably amorphous.

$$n = 1.65 \pm .$$

Some colorless fibers have negative elongation.

$$\alpha = 1.645. \qquad \gamma = 1.656.$$

See Equeiite (p. 176).

KOPPITE.

Kaiserstuhl, Baden (Col. Roebling). In section red to nearly colorless. Isotropic.

n ranges from 2.12 to 2.18.

LAGONITE.

Monte Cerbola, Tuscany (Harvard). Mineral somewhat uncertain. Pale yellow and isotropic in section.

$$n = 1.64 \pm \text{ (variable)}.$$

LANARKITE.

Leadhills, Scotland (U. S. N. M. 84657). Plates and fibers. Optically $-$, 2V rather large, $\rho > v$ (strong), X emerges from the cleavage plates.

$$\alpha = 1.93 \pm 0.01. \qquad \beta = 1.99 \pm 0.01. \qquad \gamma = 2.01 \pm 0.01.$$

LÅNGBANITE.

Långban, Sweden (U. S. N. M.). Optically $-$, reddish brown in section and translucent only in thin splinters. Absorption not strong, $\omega > \epsilon$.

$$\omega_{Li} = 2.36 \pm 0.02. \qquad \epsilon_{Li} = 2.31 \pm 0.02.$$

Some grains are perceptibly isotropic but otherwise similar.

LANGITE.

1. Cornwall, England (U. S. N. M., Shepard Coll. 1244). Bluish green, fibrous crusts. Optically $-$, 2V = 81° (indices), $\rho > v$ (?) (rather strong). Laths are normal to X and elongated parallel to Z. Faintly pleochroic in pale green; absorption Z > X.

$$\alpha = 1.708 \pm 0.005. \qquad \beta = 1.760 \pm 0.005. \qquad \gamma = 1.798 \pm 0.005.$$

Material is not entirely satisfactory. It differs sufficiently from brochantite to distinguish it.

Two specimens labeled langite from Klausen, Tyrol, were examined, but they were not langite.

2. Klausen, Tyrol (U. of C.). Not homogeneous. Chiefly a finely fibrous mineral. Optically— (?), elongation—; extinction angle not large.

$$\alpha = 1.64 \pm 0.02. \qquad \gamma = 1.86 \pm 0.02.$$

Data not very satisfactory. See Tagilite (p. 140).

3. Klausen, Tyrol (U. S. N. M. 52052). Not homogeneous. Chiefly fibers that have the following properties: Pale greenish, optically +, 2V small, elongation +.

$$\alpha = 1.552 \pm 0.005. \qquad \beta = 1.555 \pm 0.005. \qquad \gamma = 1.565 \pm 0.005.$$

LANTHANITE.

Near Bethlehem, Pa. (J. H. U.). Optically—, 2E = 111° ± 5°, 2V = 63° ± 3° (measured). Dispersion not noticed. Lie on a face normal to X; hence $X = c$.

$$\alpha = 1.52 \pm 0.01. \qquad \beta = 1.587 \pm 0.003. \qquad \gamma = 1.613 \pm 0.003.$$

LARDERELLITE.

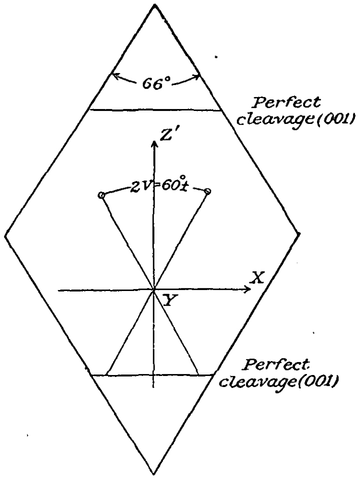

FIGURE 9.—Optical orientation of tabular crystals {100} of larderellite.

Larderello, Italy (U. S. N. M. 85174). Thin tablets with rhombic outline and an angle of 66° between the edges. A very perfect cleavage is nearly normal to the plates and bisects the obtuse angle of the rhombs. On these rhombs Z′ bisects the acute angle, and Y makes a large angle with the normal to the plates. A fragment lying on the cleavage face is nearly normal to Z and gives parallel extinction with X parallel to the elongation. Sections turned on one of the crystal faces {011} (?) give X′ to length 24°. From these data the mineral appears to be monoclinic and if the flat face is assumed to be {100} the cleavage is {001} and the other faces are probably {011}, etc. $X = b$, Z is nearly normal to {001}, and $Z \wedge c = 24° +$. A sketch of a crystal is shown in figure 9. Optically +, 2V moderate.

$$\alpha = 1.509 \pm 0.003. \qquad \beta = 1.52 \pm 0.01. \qquad \gamma = 1.561 \pm 0.003.$$

LAUBANITE.

1. Wingendorf, near Lauban, Silesia (Mr. Holden). White fibers. Uniaxial +, probably has a perfect prismatic cleavage.

$\omega = 1.475 \pm 0.003$. $\epsilon = 1.486 \pm 0.003$.

2. A specimen labeled "Laubanite on natrolite, Winegedocker, Steinbruch, Lauban," from Col. Roebling showed the following properties and is probably bavenite. Interwoven fibers. Optically +, 2V moderate, $\rho > v$ (rather strong) (?).

$\alpha = 1.584 \pm 0.005$. $\gamma = 1.588 \pm 0.005$.

LAUTARITE.

Tatal, Lautare, Africa (Col. Roebling). Optically +, 2V nearly 90°, $\rho > v$ (moderate), cleavage piece shows an optic axis emerging on the edge of the field of the microscope.

$\alpha = 1.792 \pm 0.003$. $\beta = 1.840 \pm 0.003$. $\gamma = 1.888 \pm 0.003$.

LAWRENCITE.

Artificial sublimed $FeCl_3$, prepared by Dr. Allen, of the geophysical laboratory of the Carnegie Institution of Washington. Minute hexagonal plates. Uniaxial −.

$\omega = 1.567 \pm 0.005$.

Birefringence rather weak.

LEADHILLITE.

Leadhills, Scotland (U. S. N. M. 84486). Optically−, $2E = 17\frac{1}{2}° \pm 1°$, $2V_{Na} = 9° \pm 1°$ (at 22° C.) (measured), $\rho < v$ (strong). X is perceptibly normal to the plates.

$\alpha = 1.87 \pm 0.01$. $\beta = 2.00 \pm 0.01$. $\gamma = 2.01 \pm 0.01$.

LECONTITE.

Las Piedras, Honduras (Col. Roebling). Optically−, $2E = 60° \pm 2°$, $2V = 40° \pm 1°$ (measured), $\rho < v$ (rather strong).

$\alpha = 1.440 \pm 0.003$. $\beta = 1.452 \pm 0.003$. $\gamma = 1.453 \pm 0.003$.

LEPIDOMELANE.

Rockport, Mass. (U. S. N. M. 82019). "Cryophyllite." Optically −, 2V nearly 0, green in section.

$\beta = 1.64 \pm 0.01$.

Birefringence as in biotite.

LEUCOCHALCITE.

Sommerthal, in the Spessart, Germany (U. S. N. M. 46153). White, silky fibers. Optically +, 2V large, $\rho < v$ (strong). Y perceptibly parallel to fibers.

$\alpha = 1.79 \pm 0.01$. $\beta = 1.807 \pm 0.003$. $\gamma = 1.84 \pm 0.01$.

LEUCOPHOENICITE.

1. Franklin Furnace, N. J. (U. S. N. M. 84964). In section colorless. Optically −, $2V = 74° \pm 5°$ (indices), $\rho > v$ (slight).

$\alpha = 1.751 \pm 0.003$. $\beta = 1.771 \pm 0.003$. $\gamma = 1.782 \pm 0.003$.

2. Franklin Furnace, N. J. (U. S. N. M., Study coll.). Optically −, 2V (large).

$\alpha = 1.760 \pm 0.005$. $\beta = 1.778 \pm 0.005$. $\gamma = 1.790 \pm 0.005$.

LEUCOSPHENITE.[30]

Narsarsuk, Greenland. Colorless, tabular, prismatic crystal. X is parallel to the elongation and Y is normal to the tablets. Optically +, 2V rather large, $\rho > v$ (rather strong).

$\alpha = 1.640 \pm 0.003$. $\beta = 1.657 \pm 0.003$. $\gamma = 1.684 \pm 0.003$.

LEVYNITE.

Table Mountain (U. S. N. M.). Uniaxial −.

$\omega = 1.496$. $\epsilon = 1.491$.

LEWISITE.

Minas Geraes, Brazil (A. M. N. H.). Isotropic, nearly colorless.

$n = 2.20 \pm 0.01$.

LIBETHENITE.

1. Libethen, Hungary (U. of C.). Dark-green, octahedral crystals. Optically −, 2V nearly 90°, $\rho > v$ (strong). Faintly pleochroic.

$\alpha = 1.701 \pm 0.003$; pale blue with a yellowish cast. $\beta = 1.743 \pm 0.003$.
$\gamma = 1.787 \pm 0.003$; pale blue with a greenish cast.

2. Cornwall, England. Labeled "Olivenite." Optically −, 2V nearly 90°, $\rho > v$ (strong). Pale green in section and nonpleochroic.

$\alpha = 1.704 \pm 0.003$. $\beta = 1.747 \pm 0.003$. $\gamma = 1.790 \pm 0.003$.

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[30] The data of Flink (Meddelelser om Grönland, vol. 24, p. 137, 1901) are inconsistent. He was evidently in error in stating that the mineral is optically −.

LIEBIGITE.

Specimens from Schneeberg, Saxony (U. S. N. M. 45643; Yale, B. Coll. 2995), and from Joachimsthal, Bohemia (A. M. N. H.), proved to be identical with uranothallite.

See Uranothallite (p. 151).

LINDACKERITE.

Joachimsthal, Bohemia (Col. Roebling). Pale apple-green fibers. Optically +, 2V 73° ± 5° (indices), $\rho < \upsilon$ (strong). Cleavage or crystal face showing emergence of Y nearly normal to it gives the angle X′ to elongation 26°.

The mineral is probably monoclinic, with perfect cleavage {010}. Y = *b* and the angle X to elongation 26°.

$\alpha = 1.629 \pm 0.003$. $\beta = 1.662 \pm 0.003$. $\gamma = 1.727 \pm 0.003$.

LIROCONITE.

Cornwall, England (U. S. N. M. 12567). Optically −, 2V = 72° ± 5° (indices), $\rho < \upsilon$ (moderate). Color of section of about normal thickness is calamine blue to turquoise green. Nonpleochroic.

$\alpha = 1.612 \pm 0.003$. $\beta = 1.652 \pm 0.003$. $\gamma = 1.675 \pm 0.003$.

LISKEARDITE.

Liskeard, Cornwall, England (A. M. N. H.). Clear, pale-green crust, radiating fibers. Optically +, 2V nearly 90°, Z parallel to elongation. The indices of refraction vary about ± 0.01; the values given are near the average.

$\alpha = 1.661 \pm 0.005$. $\beta = 1.675 \pm 0.005$. $\gamma = 1.689 \pm 0.005$.

LITHARGE.

See Massicot (p. 105).

LIVINGSTONITE.

Huitzuco, Mexico (U. of C.). Probably optically −, Z parallel to length of prisms. Pleochroism moderate in red with absorption X > Z.

$\alpha_{Li} =$ much above 2.72.

Birefringence extreme.

LOEWIGITE.

Zabrze, Upper Silesia (Col. Roebling). Cryptocrystalline.

$n = 1.575 \pm 0.01$.

Birefringence about ± 0.01. Compare with Alunite (p. 187).

LORANDITE.

Allchar, Macedonia (U. S. N. M. 83623). Probably optically +, cleaves into needles which have + elongation. Deep red in section.

α_{Li} considerably greater than 2.72; shows moderate relief.
γ_{Li} much greater than 2.72; shows strong relief.

Birefringence extreme. Decomposes in selenium melts unless great care is taken to prevent too high heating.

LOSSENITE.

Laurium, Greece (U. S. N. M. 84859). Optically +, $2E = 100° \pm 10°$, $2V = 50° \pm 5°$ (measured), $\rho > \upsilon$ (strong).

$\alpha = 1.783 \pm 0.003$. $\beta = 1.788 \pm 0.003$. $\gamma = 1.818 \pm 0.003$.

LUCINITE.

Lucin, Utah (type material from W. T. Schaller). Emerald-green octahedral crystals. Optically —, $2E = 98° \pm 2°$, $2V = 57° \pm 1°$ (measured), $\rho > \upsilon$ (moderate).

$\alpha = 1.563 \pm 0.003$. $\beta = 1.585 \pm 0.003$. $\gamma = 1.592 \pm 0.003$.

Compare with Peganite (p. 118).

LUDLAMITE.

Cornwall, England (U. S. N. M. 84614). Optically +, 2V large.

$\alpha = 1.653 \pm 0.003$. $\beta = 1.675 \pm 0.003$. $\gamma = 1.697 \pm 0.003$.

LUDWIGITE AND MAGNESIOLUDWIGITE.

1. Hungary (analyzed, W. T. Schaller). Contains 15.84 per cent FeO. Very dark fibers, strongly pleochroic. Optically +, 2V small, Z = elongation.

α and $\beta = 1.85 \pm 0.01$; very dark green. $\gamma = 2.02 \pm 0.02$; nearly opaque.

2. Morawitza, Banat (Col. Roebling). Black needles. Strongly pleochroic and nearly opaque. Optically +, 2V small, Z parallel to the elongation.

$\alpha = 1.84 \pm 0.02$; dark green. β = near α. $\gamma = 2.05 \pm 0.05$; dark reddish brown.

3. Head of Big Cottonwood Canyon, Lake mine, near Brighton, Utah (B. S. Butler). Black needles. Strongly pleochroic and nearly opaque. X and Y are greenish, Z is nearly opaque.

$\alpha = 1.85 \pm 0.01$.

Birefringence very strong.

4. Head of Big Cottonwood Canyon, Lake mine, near Brighton, Utah (W. T. Schaller). Black crystals. In section strongly pleochroic. Optically +, 2V very small, $\rho > v$ (extreme).

α and $\beta = 1.83 \pm 0.01$; bright green. $\gamma = 1.97 \pm 0.01$; dark reddish brown.

5. Philipsburg, Mont. (analyzed, W. T. Schaller). Contains 7.27 per cent FeO. Intermediate between ludwigite and magnesioludwigite. Black fibers. In section nearly opaque and strongly pleochroic, with absorption $\gamma > \alpha$ and β.

$$\beta = 1.86 \pm 0.01.$$

Birefringence very strong.

6. Magnesioludwigite. Head of Big Cottonwood Canyon, Lake mine, near Brighton, Utah (analyzed, W. T. Schaller). Contains 2.55 per cent FeO. Dark-green fibers. Strongly pleochroic and deeply colored. Optically +, 2V small, elongation +.

α and $\beta = 1.85 \pm 0.01$; bright green. $\gamma = 1.99 \pm 0.02$; dark reddish brown.

LUENEBURGITE.

Lüneburg, Germany (U. S. N. M. 85104). Overlapping plates. When turned on edge they lie approximately parallel to the plane of the optic axes and show a very large extinction angle. Probably monoclinic with $Y = b$. Optically −, 2V moderate.

$\alpha = 1.520 \pm 0.005$. $\beta = 1.54 \pm 0.01$. $\gamma = 1.545 \pm 0.005$.

MACKINTOSHITE.

Llano County, Tex. (Col. Roebling). A dull black cube. Vitreous luster on fresh surface. In powder clear but dusted with black specks, isotropic.

$$n = 1.77 \pm 0.01.$$

MAGNESIOLUDWIGITE.

See Ludwigite (p. 103).

MALACHITE.

Copper Queen mine, Ariz. (U. of C.). Optically −, $2E_{Na} = 86 \pm 3°$, $2V_{Na} = 43° \pm 2°$ (measured), $2V = 39° \pm 2°$ (indices), $\rho < v$ (rather strong). X is nearly normal to the cleavage plates. Strongly pleochroic.

$\alpha = 1.655 \pm 0.003$; nearly colorless. $\beta = 1.875 \pm 0.003$; yellowish green. $\gamma = 1.909 \pm 0.003$; deep green.

MANGANITE.

1. Thuringia, Germany (U. of C.). Opaque except in thin splinters. Optically +, 2V small. Cleavage pieces show Y normal to cleavage and Z parallel to the elongation. Slightly pleochroic with absorption Z > X.

$\alpha_{Li} = 2.25 \pm 0.02$; reddish brown. $\beta_{Li} = 2.25 \pm 0.02$.
$\gamma_{Li} = 2.53 \pm 0.02$; red-brown.

2. Hungary (U. of C.). Characters as in No. 1.
α and $\beta_{Li} = 2.25 \pm 0.01$.

3. Markhamsville, Kings County, New Brunswick (U. S. N. M. 45711). Optically +, 2V small, Y normal to cleavage, Z parallel to elongation. Faintly pleochroic in red-brown. Absorption Z > X.

$\alpha_{Li} = 2.23 \pm 0.02$. $\gamma_{Li} = 2.53 \pm 0.02$.

Manganite is commonly stated to be optically −, with Y = *c* and X = *b*. The data here given show that it is optically +, with Y = *b* and Z = *c*.

MANGANOSITE.

1. Franklin Furnace, N. J. (Col. Roebling). In section clear emerald-green. Isotropic.

$n = 2.16 \pm 0.01$.

2. Nordmark, Sweden (U. S. N. M. 84132). In section clear emerald-green. Isotropic.

$n = 2.16 \pm 0.01$.

MANGANOSTIBIITE.

Nordmark, Sweden (Col. Roebling). Rods and fibers, nearly opaque, with + elongation. Strongly pleochroic. Sections showing X across the length gives perceptibly parallel extinction; other sections show very large extinction angles. Probably monoclinic with X = *b*.

$\alpha = 1.92 \pm 0.02$; reddish brown. $\gamma = 1.96 \pm 0.02$; nearly opaque.

MARGARITE.

1. Chester, Mass. (U. S. N. M. 92834). Coarse pink plates. Optically −, 2E from small to 69°. 2V maximum, 40°.

$\alpha = 1.632 \pm 0.003$. $\beta = 1.645 \pm 0.003$. $\gamma = 1.647 \pm 0.003$.

2. Gainesville, Ga. (U. S. Geol. Survey). Fibrous decomposition of corundum.

$\alpha = 1.632 \pm 0.003$. $\beta = 1.643 \pm 0.003$. $\gamma = 1.645 \pm 0.003$.

MARGAROSANITE.

Franklin Furnace, N. J. (type material from Prof. Ford). Optically −, 2V = 83° ± 5° (indices), $\rho < v$ (perceptible).

$\alpha = 1.729 \pm 0.005$. $\beta = 1.773 \pm 0.003$. $\gamma = 1.807 \pm 0.005$.

MARIPOSITE.

Randsburg, Calif. (F. L. Hess). Green pleochroic mica. Optically −, 2V nearly 0.

$\beta = 1.63$.

Birefringence about 0.04.

MARTINITE.

Curaçao, West Indies (F. A. Canfield). Drusy crystals in cavities in replaced gypsum. The crystals are minute tablets with a rhombic outline. The acute angle of the rhombs is about 74°. The acute bisectrix (Z) makes a moderate angle with the normal to the plates, and an optic axis emerges on the edge of the field. Y bisects the obtuse angle of the rhombs. Optically +, 2V moderately large. The crystals are zoned, and the indices of refraction vary somewhat.

$\beta = 1.605 \pm 0.01$.

Birefringence about 0.02.

The mineral is probably monoclinic, and the crystal axis *b* bisects the obtuse angle of the rhombs and Y = *b*.

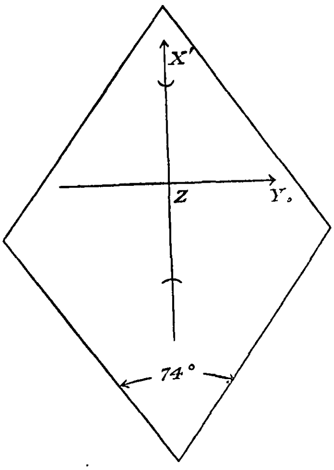

FIGURE 10.—Optical orientation of tablets {100} of martinite.

The more massive part is finely fibrous and has an index of refraction of about 1.59.

MASSICOT AND LITHARGE.

Two modifications of artificial plumbic oxide (PbO) have been recognized; a yellow orthorhombic modification is called massicot and a red tetragonal modification is called litharge. Crystals of natural plumbic oxide that were examined by the author proved to be made up of crystals of the orthorhombic form more or less inverted on the margin of the crystals to the tetragonal modification. It seems best to adopt the names given to the artificial products for the minerals.[31]

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[31] In a former paper (Am. Mineralogist, vol. 2, pp. 18–19, 1917), the author proposed that the orthorhombic form be called litharge and the tetragonal massicot, but as the most common usage for the artificial products is the opposite of this it is here proposed that the names be interchanged.

The properties of the two forms, therefore, are as follows:

Massicot occurs in yellow orthorhombic, rectangular tablets parallel to {100}. It is biaxial+; X (or possibly Y) is normal to the plates; 2V is large.

$$\beta_{Li}=2.61\pm0.04.$$

Birefringence very strong; specific gravity 9.29.

Litharge occurs in red tetragonal tablets parallel to {001}, with a cleavage {110}. It is uniaxial−.

$$\omega_{Li}=2.64\pm0.04.$$

Birefringence very strong; specific gravity 9.126.

1. Artificial massicot (assayer's "litharge"). Orange-yellow powder. In plates normal to X (or Y), optically+.

$$\beta_{Li}=2.61\pm0.04.$$

Birefringence very strong.

2. Cucamongo Peak, San Bernardino County, Calif. (U. S. N. M. 86525). Brownish orange-red scales, the largest of them 1 millimeter across and very soft. Made up of about equal quantities of litharge and massicot. The litharge borders the massicot and is no doubt derived from it. The massicot is nearly colorless in section. Lies on plates normal to X (possibly Y) and is biaxial+.

$$\beta=2.61\pm0.04.$$

Birefringence strong.

The litharge is yellow-orange in section, uniaxial, optically−, and has the optic axis normal to the plates.

$$\omega=2.64\pm0.02.$$

Birefringence very strong.

3. Austria (U. of C.). White powder of mineral (A), probably a hydrous lead oxide, with a few glistening scales of massicot and litharge (B).

A. Very minute fibers, with $\gamma=2.03\pm0.03$. Some of these show $\gamma=2.03$, α below 1.97. Compare with Hydrocerusite (p. 202).

B. The scales are made up of a core of nearly colorless massicot and an irregular border of red litharge; a paramorph after the massicot.

The massicot is nearly colorless in section, optically+, 2V large, β much above 2.10, birefringence strong. Plates are normal to X (possibly Y).

The litharge is red, uniaxial−, with the optic axis perceptibly normal to the plates. ω much above 2.10. Birefringence rather strong.

4. Fort Tejon, Kern County, Calif. (U. of C.). "Mennige." Similar to the material from Austria. The massicot is in scales

normal to X (or Y). These show a cleavage or other structure parallel to Y (or X).

$$n_{Li} = 2.62 \pm 0.04.$$

Birefringence strong.

5. Western Tasmania (U. S. N. M. 84683). Yellow powder. Very finely crystalline to amorphous.

$$n \text{ less than } 2.20.$$

Two specimens labeled massicot from Tasmania do not agree with either massicot or litharge.

6. Durden, Tasmania (U. S. N. M. 84620). Canary-yellow powder. Characters like those of No. 5. Some cerusite.

MATLOCKITE.

Cramford, Derbyshire, England (U. S. N. M. 80353). Optically −, perceptibly uniaxial.

$$\omega = 2.15 \pm 0.01. \qquad \epsilon = 2.04 \pm 0.01.$$

MAZAPILITE.

See Arseniosiderite (p. 42).

MELANOCERITE.

1. Langesund, Norway (Prof. Brögger, U. of Stockholm). Dark reddish-brown tabular crystal. Uniaxial −, pale yellowish in section and nonpleochroic.

$\omega = 1.73 \pm 0.01$; varies somewhat. $\epsilon = 1.72 \pm 0.01$; varies somewhat.

2. Langesund fiord, Norway (U. S. N. M. 84329). Completely altered to a reddish-brown isotropic product.

$$n = 1.77 \pm 0.01.$$

3. Langesund fiord, Norway (A. M. N. H.). Characters similar to those of No. 2 but contains moderately birefracting fibers.

$$n = 1.77.$$

MELANOPHLOGITE.

Racamuto, Sicily (U. S. N. M. 84311). Glassy and isotropic.

$$n = 1.461 \pm 0.003 \text{ in large part.}$$

A rather distinct border has $n = 1.450 \pm 0.003$.

MELANOTEKITE.

Långban, Sweden (J. H. U.). Black grains. Optically +, 2V = 67° ± 5° (indices), $\rho < v$ (rather strong), pleochroism intense.

$\alpha = 2.12 \pm 0.01$; nearly colorless. $\beta = 2.17 \pm 0.01$; pale reddish brown. $\gamma = 2.31 \pm 0.01$; deep reddish brown.

MENDIPITE.

Brilon, Westphalia (A. M. N. H.). Nearly colorless, cleavable masses. Optically +, 2V nearly 90°, $\rho < v$ (very strong), Z parallel to elongation.

$\alpha = 2.24 \pm 0.02$. $\beta = 2.27 \pm 0.02$. $\gamma = 2.31 \pm 0.02$.

MENDOZITE.

1. Mendoza, Argentina (Col. Roebling). Minute, interwoven fibers. Apparently uniaxial, optically −, elongation −.

$\alpha = 1.431 \pm 0.003$. $\beta = 1.459 \pm 0.003$. $\gamma = 1.459 \pm 0.003$.

2. Box Elder County, Utah (F. M. N. H. Chicago). This specimen is made up chiefly of two minerals, A and B.

A. Clouded grains. Optically −, 2V very small, dispersion not perceptible.

$\alpha = 1.434 \pm 0.003$. $\beta = 1.455 \pm 0.003$. $\gamma = 1.456 \pm 0.003$.

This material is probably mendozite.

B. Laths. On the tabular face they show parallel extinction with Z across the laths. When turned on edge they show Y elongation 30° ±. Optically +.

$\alpha = 1.484 \pm 0.003$. $\gamma = 1.493 \pm 0.003$.

This is probably tamarugite. The mineral is probably monoclinic (or triclinic). If the tabular face is taken as {100} the elongation is *c* and $Z = b$, $Y \wedge c = 30°$.

3. Artificial mendozite. The crystallization of a solution containing Na_2SO_4 and $Al_2(SO_3)_4$ in a desiccator at about 20° C., in about the proportion to form mendozite, gave coarse, pointed, lath-shaped crystals, which had the following optical properties:

Optically −, 2E = 85½° ± 1°, 2V = 56° ± 1° (measured). Dispersion slight.

$\alpha = 1.449 \pm 0.003$. $\beta = 1.461 \pm 0.003$. $\gamma = 1.463 \pm 0.003$.

Crystals that lie on the flat face show parallel extinction and the obtuse bisectrix emerges from the edge of the field. The plane of the optic axis is across the laths. Crystals that are turned on edge give an extinction angle of 30° ± 1°. The crystals are therefore monoclinic, with the flat face {100} and the elongation c; $X=b$, $Y \wedge c=30°$. There is a perfect cleavage {010}. This material differs somewhat from natural mendozite, and it is the same as the artificial monoclinic modification mentioned by Groth.[32]

On standing in air or in a desiccator these glassy crystals break down in a few days to a white powder which has the following properties:

Minute fibers in layers, probably monoclinic with $Z=b$ and a large extinction angle. Optically +, 2V moderate.

$\alpha=1.484\pm0.003$. $\beta=1.488\pm0.003$. $\gamma=1.499\pm0.003$.

This material corresponds to tamarugite.

MESITITE.

Piedmont (U.S.N.M. 81665). Nearly homogeneous. Uniaxial −.

$\omega=1.68\pm0.01$.

Birefringence as in calcite.

MESSELITE.

Darmstadt, Germany (U. S. N. M. 51823). Optically +, 2V moderate, dispersion not strong. Appears to have a good cleavage, from which an optic axis emerges just out of the field of the microscope.

$\alpha=1.644\pm0.003$. $\beta=1.653\pm0.003$. $\gamma=1.680\pm0.003$.

METABRUSHITE.

Sombrero, West Indies (J. H. U.). Optically +, 2V large, Z emerges from the cleavage plates.

$\alpha=1.535\pm0.005$. $\beta=1.539\pm0.005$. $\gamma=1.545\pm0.005$.

This material agrees with brushite.

METAVOLTAITE.

1. Sierra de Caporasee, Chile (Col. Roebling). Canary-yellow powder with voltaite. Under the microscope it is seen to be made up of minute yellow, hexagonal scales. When turned on edge they are birefracting and pleochroic in yellow, with absorption $\omega>\epsilon$. Optically −.

$\omega=1.588\pm0.005$. $\epsilon=1.578\pm0.005$.

2. Peru (type, Prof. Lacroix). Hexagonal plates, much coarser than No. 1. Uniaxial −, strongly pleochroic.

$\omega=1.591\pm0.003$; deep orange-yellow. $\epsilon=1.573\pm0.003$; very pale yellow.

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[32] Groth, P., Chemische Krystallographie, vol. 3, p. 565, 1910.

MEYERHOFFERITE.

Inyo County, Calif. Type material (W. T. Schaller). Colorless. Optically —, $2V=79° \pm 5°$ (indices), $\rho > v$ (perceptible). Extinction on the cleavage plates {010} $X' \wedge c=33°$, on {100} $Z \wedge c=25.3°$.

$\alpha=1.500 \pm 0.003$. $\beta=1.535 \pm 0.003$. $\gamma=1.560 \pm 0.003$.

MIARGYRITE.

Rising Star mine, Idaho (U. of C.). Optically +, 2V moderate, nearly opaque.

$\alpha > 2.72$.

Birefringence very strong.

MICROLITE.

Amelia, Va. (Univ. of Virginia). Isotropic and colorless in section.

$n=1.930 \pm 0.005$.

MIERSITE.

Broken Hill, New South Wales (Harvard). Pale-greenish crystals. Isotropic with anomalous birefringence.

$n=2.20 \pm 0.02$.

MILARITE.

Granbünnden, Switzerland (U. S. N. M. 47014). Hexagonal. Optically —.

$\omega=1.532$.

Birefringence about 0.003.

MIMETITE.

1. Chihuahua, Mexico (U. S. N. M.). Crystals. Uniaxial —, colorless in section.

$\omega=2.135 \pm 0.010$. $\epsilon=2.120 \pm 0.010$.

2. Durango, Mexico (U. S. N. M.). Analyzed, pure. Pseudomorph. The indices vary a little.

$\omega=2.136 \pm 0.010$. $\epsilon=2.122 \pm 0.010$.

3. Tintic district, Utah (U. S. N. M. 85013). Optically —, prismatic crystals.

$\omega=2.14 \pm 0.01$. $\epsilon=2.13 \pm 0.01$.

MINASRAGRITE.

Minasragra, Peru. Type material (U. S. N. M. 87515). Optically —, 2V medium large. Fragments showing X and Z′ give parallel extinction. Crystals tend to lie on a face or cleavage normal to X. Z makes a small angle with the elongation. Probably monoclinic, with $X=b$. Strongly pleochroic.

$\alpha=1.518\pm0.003$; deep blue. $\beta=1.530\pm0.003$; pale blue. $\gamma=1.542\pm0.003$; nearly colorless.

MINIUM.

1. Rock mine, Leadville, Colo. (U. S. N. M. 84426). In section very minutely crystalline shreds. Strongly pleochroic. Parallel to the elongation, deep reddish brown; normal to the elongation, nearly colorless.

$n_{Li}=$ about 2.40.

Birefringence weak. Abnormal green interference colors are characteristic.

2. Specimens from a number of other occurrences were examined but gave no better data.

MIRABILITE.

Carrizo Plains, Calif. Recrystallized. Optically −, 2V large. Dispersion of optic axis slight, dispersion of bisectrices strong, and sections normal to Bx_a (X) give abnormal interference colors without extinction in white light and show strong crossed dispersion; other sections give sharp extinction.

$\alpha=1.394\pm0.003$. $\beta=1.396\pm0.003$. $\gamma=1.398\pm0.003$.

MISENITE.

Cape Misene, Italy (Col. Roebling). Silky fibers. Probably optically +, with a large axial angle. $Z \wedge$ elongation $=33°$.

$\alpha=1.475\pm0.003$. $\beta=1.480\pm0.003$. $\gamma=1.487\pm0.003$.

MIXITE.

1. Tintic district, Utah (U. of C.). Minute, bluish-green, acicular crystals. Optically +, 2V nearly or quite 0, extinction perceptibly parallel and elongation +. Pale green in section and nonpleochroic.

$\omega=1.743\pm0.003$. $\epsilon=1.830\pm0.003$.

2. Mammoth mine, Tintic, Utah (U. S. N. M. 48246). Part of type analyzed. Minute green cotton-like fibers. Extinction parallel, elongation +, pleochroic. Optically + and either uniaxial or with a small axial angle, as the index across the fibers is perceptibly the same for all fibers.

$\omega=1.730\pm0.003$; nearly colorless. $\epsilon=1.810\pm0.003$; bright green.

MOISSANITE.

Commercial carborundum. Uniaxial +.

$$\alpha_{\mathrm{Li}} = 2.65 \pm 0.02.$$

Birefringence moderate.

MOLYBDITE.

All the specimens examined consist of a canary-yellow powder made up of minute needles which must be optically + with a small axial angle, as the index of refraction across the length appears to be about the same for all fibers of each specimen. Extinction is parallel, Z = elongation.

1. Buena Vista, Colo.

α and $\beta = 1.750 \pm 0.01$; nearly colorless. $\gamma = 1.87$ approximately; grayish.

2. Hortense, Colo. Similar to No. 1, but $\alpha = 1.780$.
3. Locality 2 miles south of Placerville, Colo.

α and $\beta = 1.785 \pm 0.005$; nearly colorless. $\gamma = 2.05 \pm 0.02$; grayish.

4. No locality (U. of C.). Optically +, $2V = 28°$ (measured).

$\alpha = 1.720 \pm 0.005$; colorless. $\beta = 1.733 \pm 0.005$; colorless.
$\gamma = 1.935 \pm 0.005$; pale canary-yellow.

5. Stuart Ledge, Tuolumne County, Calif. (U. of C.).

$\alpha = 1.720 \pm 0.003$; nearly clear and colorless.
$\beta = 1.73$; nearly clear and colorless.
$\gamma = 1.935 \pm 0.005$; cloudy yellow.

6. Buena Vista, Colo. (U. of C.).

α and $\beta = 1.72$ to 1.76, chiefly 1.745; clear. $\gamma = 1.94 \pm 0.01$; cloudy yellowish.

MONETITE.

Moneta, West Indies (U. S. N. M.). Optically +, 2V moderately large, X emerges from the cleavage.

$\alpha = 1.515 \pm 0.003$. $\beta = 1.518 \pm 0.003$. $\gamma = 1.525 \pm 0.003$.

MONTANITE.

Uncle Sam lode, Helena, Mont. (U. S. N. M. 12657). Successive layers of fibers. Optically −, 2V small, $\rho < v$ (extreme). Fibers tend to lie on a face nearly normal to X. The material alters on heating.

$$\beta = 2.09 \pm 0.03.$$

Birefringence about 0.01. Gives very abnormal green interference colors.

MONTMORILLONITE.

1. Millac, France (Prof. Lacroix). Red clay with opaline appearance. Under the microscope it is seen to be rather coarsely crystalline in interwoven fibers. Optical data are not consistent, possibly owing to aggregate effects. The best data indicate an optically — mineral with small axial angle, but some fragments seem to be optically + with a large axial angle.

$$\beta = 1.560 \pm 0.01.$$

Birefringence about 0.02. Compare with Leverrierite (p. 247).

2. Severite. St. Sever, France (Prof. Lacroix). White chalky mass. Mainly isotropic to indistinctly crystalline, but there are a few birefracting shreds. The index of refraction of the main part is 1.548 ± 0.005.

Montmorillonite is an uncertain species and in common with most of the clay minerals needs further study.

MONTROYDITE.

Texas. (Type U. S. N. M. 86637). Probably optically+, Y (?) normal to very perfect cleavage. Z parallel to the length. The plates could not be turned from this cleavage, and the constants given assume that the cleavage is parallel to the plane of the optic axis.

$$\alpha_{Li} = 2.37 \pm 0.02. \qquad \gamma_{Li} = 2.65 \pm 0.02.$$

MORDENITE.

Morden, Nova Scotia (Col. Roebling). Fibrous mineral. Optically +.

$$\beta = 1.465.$$

Birefringence about 0.005.

MOSESITE.

Terlingua, Tex. (Type U. S. N. M.). Pale-yellow crystals. In large part perceptibly isotropic; some crystals show weak birefringence.

$$n = 2.065 \pm 0.010.$$

NADORITE.

Djebel-Nador, Constantine, Algeria (U. S. N. M. 84356).

$$\alpha_{Li} = 2.30 \pm 0.01. \qquad \beta_{Li} = 2.35 \pm 0.01. \qquad \gamma_{Li} = 2.40 \pm 0.01.$$

NAÉGITE.

Bis mine, Tokyo, Japan (F. L. Hess). The freshest part is clear and isotropic.

$n = 1.818 \pm 0.005$ (varies ± 0.01).

Compare with Malacon (p. 179).

NANTOKITE.

1. Artificial. Copper foil treated with hydrochloric acid and evaporated to dryness with undissolved copper. The resulting colorless cubic crystals were isotropic.

$n = 1.930 \pm 0.005$.

2. Nantokite from Nantoko, Chile (Col. Roebling), was altered.

NASONITE.

Franklin Furnace, N. J. (Yale, B. Coll. 4192). Uniaxial+, tend to lie on a cleavage parallel to the optic axis.

$\omega = 1.917 \pm 0.005$. $\epsilon = 1.927 \pm 0.005$.

NATROALUNITE.

Funeral Range, Calif. (U. S. N. M. 87527). Cryptocrystalline. May be in part amorphous.

$n = 1.568 \pm 0.003$.

Birefringence moderate.

NATROJAROSITE.

Soda Springs Valley, Esmeralda Valley, Nev. (U. S. N. M. 86932). Hexagonal plates with pyramids. Uniaxial−, faintly pleochroic.

$\omega = 1.832 \pm 0.005$; pale yellowish. $\epsilon = 1.750 \pm 0.005$; nearly colorless.

NATRON.

Crystals from solution of Na_2CO_3 in water at 22° C. They lose water quickly on exposure to air. Optically−, 2V large, $\rho > \upsilon$ (perceptible).

$\alpha = 1.405 \pm 0.003$. $\beta = 1.425 \pm 0.003$. $\gamma = 1.440 \pm 0.003$.

In index liquid (kerosene and fusel oil) the crystals alter rapidly, giving a drop of liquid in which there are good crystals.

NATROPHILITE.

Branchville, Conn. (U. S. N. M.). Optically+, 2E = 170° ± 10°, 2V = 72° ± 5° (measured), $\rho < v$ (strong).

$\alpha = 1.671 \pm 0.003$. $\beta = 1.674 \pm 0.003$. $\gamma = 1.684 \pm 0.003$.

NEOTANTALITE.

Les Colettes d'Allier, France (U. S. N. M. 87017). In section colorless and isotropic.

n ranges from 1.95 to 1.99; averages about 1.96.

NEOTOCITE.

Sweden (U. S. N. M. 14406). Black, coal-like, brown in powder. In transmitted light brown and in part isotropic, with $n = 1.53$ to 1.56; in part birefractory, with $n = 1.54$ to 1.58; birefringence about 0.02. The birefractory part is clearly crystallized from the amorphous part and its variable properties are probably due to incomplete crystallization, giving submicroscopically admixed amorphous material. The crystalline part is probably bementite. The name neotocite should be confined to the amorphous mineral that has approximately the composition of bementite ($MnO.SiO_2.nH_2O$). In common with most amorphous minerals, the composition of neotocite is much less definite than is that of the crystalline form, bementite.

NEPTUNITE.

San Benito County, Calif. (U. of C.). Optically+, 2V rather large, $\rho < v$ (very strong). Dispersion of bisectrices strong.

$\alpha = 1.690 \pm 0.005$. $\beta = 1.700 \pm 0.005$. $\gamma = 1.736 \pm 0.005$.

NEWBERYITE.

Skipton Caves, Ballarat, Australia (U. S. N. M. 84341). Optically+, 2V moderate, $\rho < v$ (perceptible).

$\alpha = 1.514 \pm 0.003$. $\beta = 1.517 \pm 0.003$. $\gamma = 1.533 \pm 0.003$.

NEWTONITE.

Newton County, Ark. (Col. Roebling). White, chalky. Made up of very minute square pyramids which have a nearly square outline when lying on the pyramid face. Fragments on a pyramid face show Z′ bisecting the acute angle of the rhombic outline, perceptibly uniaxial, optically+. Probably tetragonal.

$\omega = 1.560 \pm 0.005$. $\epsilon = 1.580 \pm 0.005$.

NITROCALCITE.

Artificial, made by drying a solution of calcium nitrate, $Ca(NO_3)_2$, in a desiccator at room temperature. The result was a crystalline hygroscopic mass. Biaxial−, $2E=78° \pm 3°$, $2V=50° \pm 2°$ (measured); dispersion not perceptible. X is normal to a cleavage.

$\alpha=1.465 \pm 0.003$. $\beta=1.498 \pm 0.003$. $\gamma=1.504 \pm 0.003$.

On further standing in a desiccator dried by freshly ignited calcium chloride the clear crystals of artificial nitrocalcite alter to an isotropic, chalky mass which rapidly changes to the original material on exposure to air.

$n=1.595 \pm 0.005$.

NITROGLAUBERITE.

Atacama, Chile (Col. Roebling). Optically−, $2E=98° \pm 10°$, $2V=61° \pm 5°$ (measured), $2V=68° \pm 3°$ (indices), $\rho < v$ (rather strong). Extinction is parallel. The crystals are in stout laths, tabular normal to Y and elongated along X. There is probably a perfect cleavage normal to Z.

$\alpha=1.418 \pm 0.003$. $\beta=1.500 \pm 0.003$. $\gamma=1.543 \pm 0.003$.

NITROMAGNESITE.

Madison County, Ky. (Col. Roebling). Optically−, $2E=7° \pm 1°$, $2V=5° \pm 1°$ (measured), $\rho < v$ (perceptible).

$\alpha=1.34 \pm 0.01$. $\beta=1.506 \pm 0.003$. $\gamma=1.506 \pm 0.003$.

NOCERITE.

Nocera, Italy (U. S. N. M. 84152). Uniaxial−, hexagonal cross section.

$\omega=1.512 \pm 0.003$. $\epsilon=1.487 \pm 0.003$.

OLIVENITE.

1. American Eagle mine, Tintic, Utah (analyzed by W. F. Hillebrand) (U. S. N. M. 83319). Optically+, $2V=82° \pm 5°$ (indices), $\rho < v$ (strong), in section pale green and nonpleochroic.

$\alpha=1.772 \pm 0.005$. $\beta=1.810 \pm 0.005$. $\gamma=1.863 \pm 0.005$.

2. Cornwall, England (Col. Roebling). Olive-green prismatic crystals, which lie on a face nearly normal to an optic axis and show a spiral interference figure due to twinning. 2V nearly 90°, probably in part optically−, $\rho > v$ (rather strong), and in part optically+, $\rho < v$ (rather strong). Y is parallel to the elongation.

$\alpha=1.747 \pm 0.005$. $\beta=1.788 \pm 0.005$ (ranges from 1.785 to 1.795). $\gamma=1.829 \pm 0.005$.

ORPIMENT.

Hungary (U. of C.). A cleavage piece showed X normal to the cleavage and Z parallel to the elongation. Optically +.

$\alpha_{Li} = 2.4$ approximately. $\beta_{Li} =$ somewhat above 2.72.
$\gamma_{Li} =$ much above 2.72.

Birefringence extreme. The data given are not at all satisfactory.

OXAMMITE.

Guanape, Peru (Col. Roebling). Optically −, $2V = 60° \pm 2°$ (indices), $\rho < v$ (perceptible). Poorly developed prisms with X parallel to the elongation. They tend to lie on a face normal to Y.

$\alpha = 1.440 \pm 0.003$. $\beta = 1.547 \pm 0.003$. $\gamma = 1.593 \pm 0.003$.

The following data[32] for artificial ammonium oxalate, $(NH_4)_2O.C_2O_3.H_2O$, show the identity of the two.

Optically −, $2V = 61° 44'$, $\rho < v$ (strong). $X = c$. $Y = b$.

$\alpha = 1.4383$. $\beta = 1.5475$. $\gamma = 1.5950$.

OZOCERITE.

No locality (Col. Roebling). Nearly black, waxy mass. Fibrous, elongation negative. Uniaxial +. On crushing, fragments lie on a face normal to the optic axis.

$\omega = 1.515$ approximately. $\epsilon = 1.54$ approximately.

PALAITE.

Pala, Calif. Original material (W. T. Schaller). Optically −, 2V rather large, dispersion not perceptible.

$\alpha = 1.652 \pm 0.003$. $\beta = 1.656 \pm 0.003$. $\gamma = 1.660 \pm 0.003$.

PANDERMITE.

See Priceite (p. 122).

PARAFFIN.

(Col. Roebling). Uniaxial +. On crushing, the material orients itself normal to the optic axis.

$\omega = 1.502 \pm 0.003$. $\epsilon = 1.550 \pm 0.003$.

PARAHOPEITE.

Rhodesia, Africa (Col. Roebling). Optically +, 2V very large, $\rho < v$ (perceptible). Extinction angles are large. A good cleavage piece showed the emergence of an optic axis in the field of the microscope.

$\alpha = 1.614 \pm 0.003$. $\beta = 1.625 \pm 0.003$. $\gamma = 1.637 \pm 0.003$.

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[32] Groth, P., Chemische Krystallographie, Teil 3, p. 151, 1910.

PARALUMINITE.

Halle, Germany (A. M. N. H.). Minute, interwoven fibers. Optically−, 2V small to 0, X parallel to the elongation.

$\alpha=1.462\pm0.003$. $\beta=1.470\pm0.003$. $\gamma=1.471\pm0.003$.

PARTSCHINITE.

Oláhpian, Transylvania (Col. Roebling). Red, glassy crystals. Colorless in section and isotropic.

$n=1.787\pm0.003$.

It is no doubt an ordinary garnet.

PECTOLITE.

Bergen Hill, N. J. (U. of C.). Optically+, 2V medium large, Z is parallel to the elongation.

$\alpha=1.595\pm0.003$. $\beta=1.606\pm0.003$. $\gamma=1.633\pm0.003$.

PEGANITE.

Striegis, Saxony (J. H. U.). Colorless in section. Optically−, 2E = 89° ± 5°, 2V = 53° ± 3° (measured), dispersion not noticed. There is probably a cleavage normal to X and others. Extinction is parallel.

$\alpha=1.562\pm0.003$. $\beta=1.583\pm0.003$. $\gamma=1.587\pm0.003$.

PENFIELDITE.

Laurium, Greece (Col. Roebling). Colorless. Uniaxial+.

$\omega=2.13\pm0.01$. $\epsilon=2.21\pm0.01$.

PERCYLITE.

No locality (U. of C.). Sky-blue cubes. Sky-blue in section and isotropic.

$n=2.05\pm0.01$.

Partly altered to boleite.

$\omega=2.06\pm0.01$.

Birefringence 0.02.

PHARMACOSIDERITE.

Cornwall, England (U. S. N. M. 45330). Clear, emerald-green crystals. Optically −, 2V medium large, $\rho>v$ (very strong), dispersion of bisectrices strong. Emerald-green in powder. The cubes are divided into segments and each of these shows lamellar twinning parallel to the edges. The extinction angles are large. Some sections show no dispersion of the bisectrices. Probably monoclinic, possibly triclinic. Some fragments are optically +, $\rho < v$ (very strong).

$\beta = 1.693 \pm 0.005$ (varies somewhat).

Birefringence about 0.005.

PHOENICOCHROITE.

Berezov, Urals (Col. Roebling). Optically +. 2V = medium, $\rho > v$ (strong).

$\alpha_{Li} = 2.34 \pm 0.02$. $\beta_{Li} = 2.38 \pm 0.02$. $\gamma_{Li} = 2.65 \pm 0.02$.

See Crocoite (p. 63).

PHOLIDOLITE.

Taberg, Sweden (A. M. N. H.). Pale-green chloritic scales. Perceptibly uniaxial —, X is normal to the plates.

$\alpha = 1.503$. β and $\gamma = 1.545$.

PHOSPHURANYLITE.

Mitchell County, N. C. "From Genth." (Yale.) Very fine aggregates of yellow plates. Optically —, 2V variable but very small, $\rho > v$ (very strong). Crossed dispersion is strong, X is normal to the plates, strongly pleochroic.

$\alpha = 1.691 \pm 0.003$; nearly colorless. $\beta = 1.720 \pm 0.003$; canary-yellow. $\gamma = 1.720 \pm 0.003$; canary-yellow.

The mineral is probably monoclinic tabular {010} with X = *b*. All other specimens examined proved to be autunite.

PICKERINGITE.

Peru (U. of C.). Optically —, 2V small to medium. $Z \wedge c = 35°$ on section with strong birefringence. Y = *b*.

$\alpha = 1.476 \pm 0.003$. $\beta = 1.480 \pm 0.003$. $\gamma = 1.483 \pm 0.003$.

Not entirely homogeneous.

PICOTITE.

Rocklin, Calif. (U. of C.). Isotropic, brownish, translucent only in thin splinters.

$n = 2.05$ approximately; varies a little.

PICROPHARMACOLITE.

Riechelsdorf, Hessen (Col. Roebling). Optically +, $2E = 68° \pm 3°$, $2V = 40° \pm 2°$ (measured), $\rho < v$ (rather strong). It shows two perfect cleavages. One shows the emergence of Y and X′ to the other cleavage 37° ±; the other shows sensibly parallel extinction, Z′ parallel to cleavage. The mineral is probably monoclinic with perfect cleavages {010}, {100}, $Y = b$, and $X \wedge c = 37° \pm$.

$\alpha = 1.631 \pm 0.003$. $\beta = 1.632 \pm 0.003$. $\gamma = 1.640 \pm 0.003$.

PIEDMONTITE.

Pine Mountain, Monterey, Pa. Dark-lavender, coarsely fibrous spherulites. Optically +, $2V = 56° \pm 5°$ (indices). Strongly pleochroic in red. Absorption $Z > Y > > X$.

$\alpha = 1.758 \pm 0.003$; pale red. $\beta = 1.771 \pm 0.003$; deep red.
$\gamma = 1.819 \pm 0.003$; deep red.

PILBARITE.

Wodgina district, Australia (U. S. N. M. 87363). Amorphous.

n ranges from below 1.73 to 1.76; average 1.74.

The isotropic material is filled with minute birefracting bodies with higher index of refraction and strong birefringence.

PINAKIOLITE.

Långban, Sweden (U. S. N. M. 85171). Optically −, $2E = 69° \pm 2°$, $2V = 32° \pm 1°$ (measured), $\rho < v$(?) (moderate).

$\alpha = 1.908 \pm 0.005$. $\beta = 2.05 \pm 0.01$. $\gamma = 2.065 \pm 0.01$.

PISANITE.

1. Specimens from Ducktown, Tenn., and from Bingham, Utah, had completely altered to copper-iron chalcanthite.

2. Artificial. Crystallized from a saturated solution with molecular proportions of ferrous sulphate and cupric sulphate at 4° C. Crystals are pale blue and vitreous in mass and nearly colorless in section. Optically +, 2V very large, dispersion slight. Crystals are rectangular tablets with an angle of about 80°. An optic axis emerges from the tablets at a large angle to the normal to the tablets. Extinction of the tablets is $X' \wedge$ long edge $= 22° \pm$ in the obtuse angle. Many crystals show an hour-glass structure.

$\alpha = 1.472 \pm 0.003$. $\beta = 1.479 \pm 0.003$. $\gamma = 1.487 \pm 0.003$.

PITTICITE.

Freiberg, Saxony (Col. Roebling). Opaline and amorphous, in large part, with a conchoidal fracture. In section the color is reddish brown.

$$n = 1.635 \pm 0.005.$$

PLANCHEITE.

Type material from Kongo, Africa (W. T. Schaller, who procured it from Prof. Lacroix).

1. Minute, interwoven, blue fibers.

$$\alpha = 1.640 \pm 0.005. \qquad \gamma = 1.697 \pm 0.005.$$

Elongation +, appears to be uniaxial +, but this appearance may be due to interwoven fibers.

2. Coarser needles from a spherulite. Optically +, 2V medium, elongation +, X appears to be normal to a cleavage. The indices vary a little.

$$\alpha = 1.645 \pm 0.005. \qquad \beta = 1.660 \pm 0.005. \qquad \gamma = 1.715 \pm 0.005.$$

PLATTNERITE.

"You Like" lode, Mullan, Idaho (U.S.N.M.). Very unsatisfactory material for optical study, clouded and nearly opaque. No birefringence was recognized.

$$n_{Li} = 2.30 \pm 0.05.$$

PLEONASTE.

See Hercynite (p. 83).

PLUMBOGUMMITE.

Canton, Ga. (U. S. N. M. 44510). Uniaxial +, spherulites or successive layers of fibers. The indices of refraction vary somewhat and the values given below are about the average.

$$\omega = 1.653 \pm 0.01. \qquad \epsilon = 1.675 \pm 0.01.$$

PLUMBOJAROSITE.

Cooks Peak, N. Mex. (U. S. N. M. 8655). Analyzed. Hexagonal plates. Optically −, rather strongly pleochroic.

$\omega = 1.875 \pm 0.005$; yellow-brown. $\epsilon = 1.786 \pm 0.005$; nearly colorless.

Some of the plates divide into hexagonal segments that have a small axial angle.

POLYBASITE.

Rudolfschacht, Marienberg, Germany (U. of C.). Optically −, 2E rather small. Dark red in transmitted light.

n_{Li} above 2.72.

Birefringence strong.

POLYCRASE.

Baringer Hill, Tex. (U. S. N. M.). In section clear brown and perceptibly isotropic.

$n = 1.70 \pm 0.01$.

POLYMIGNITE.

Frederiksvärn, Norway (U. S. N. M. 12256). Reddish brown in section and perceptibly isotropic.

$n = 2.22 \pm 0.01$.

POTASH ALUM.

See Kalinite (p. 95).

POWELLITE.

Peacock Lode, Seven Devils district, Idaho (U. S. N. M. type of Melville). Very pale greenish-yellow octahedral crystals, uniaxial +.

$\omega = 1.967 \pm 0.005$. $\epsilon = 1.978 \pm 0.005$.

PRICEITE.

1. Curry County, Oreg. (Cal. Min.). White, chalky mass. Nearly homogeneous and made up of very minute shreds and rhombic plates. The angle between the edges of the rhombs measured 58° ± 1°. Optically −, 2V rather small, X makes a considerable angle with the normal to the plates. In crystals lying on the flat face Y′ makes an angle of about 14° with the line bisecting the acute angle of the rhombs.

$\alpha = 1.572 \pm 0.003$. $\beta = 1.591 \pm 0.003$. $\gamma = 1.594 \pm 0.003$.

Priceite must be triclinic in crystal symmetry.

2. Chinan Sar, Rhyndacus River, near Panderma, Turkey (U. S. N. M. 46030). "Pandermite." White chalky mass, entirely homogeneous, and made up of shreds and plates somewhat coarser than those of priceite, but the crystals are not so well formed. Optically −, $2E = 53° \pm 3°$, $2V = 32° \pm 2°$ (measured), $\rho < v$. The plates show the emergence of X on the edge of the field. Turned on edge they show an extinction Z′ to elongation, 25° ± 2°.

$\alpha = 1.573 \pm 0.003$. $\beta = 1.591 \pm 0.003$. $\gamma = 1.593 \pm 0.003$.

These data show the complete identity of priceite and pandermite. They also show that priceite is distinct from colemanite and establish it as a distinct species. The optical properties of the two species are given in the following table for comparison:

TABLE 4.—*Optical properties of priceite and colemanite.*

	Priceite.	Colemanite.
Composition	$5CaO.6B_2O_3.9H_2O$	$2CaO.3B_2O_3.5H_2O$.
Crystal system	Triclinic.	Monoclinic.
Optical sign	−	+.
2V	32°	55° 20′.
Dispersion	$\rho < \upsilon$ (rather strong)	$\rho < \upsilon$ (weak).
Angle α	1. 573	1. 586
Angle β	1. 591	1. 592
Angle γ	1. 594	1. 614

PROCHLORITE.

Waterworks Tunnel, D. C. (analyzed, U. S. N. M. 85875). Green plates. Optically +, 2V small, $\rho < \upsilon$ (rather strong). Z is perceptibly normal to the plates.

$$\beta = 1.605.$$

Birefringence low.

PROSOPITE.

Altenberg, Saxony (U. of C.). Optically +, 2V rather large, $\rho > \upsilon$ (strong).

$$\alpha = 1.501 \pm 0.003. \qquad \beta = 1.503 \pm 0.003. \qquad \gamma = 1.510 \pm 0.003.$$

PSEUDOBROOKITE.

Aranyer Berg, Hungary (U. S. N. M. 47052). In section reddish brown and filled with inclusions. Not very satisfactory for accurate optical data.

$$\alpha_{Li} = 2.38 \pm 0.02. \qquad \gamma_{Li} = 2.42 \pm 0.02.$$

PSEUDOMALACHITE.

See Dihydrite (p. 68).

PSITTACINITE.

See Cuprodescloizite (p. 64).

PUCHERITE.

Schneeberg, Saxony (U. S. N. M. 46022). Optically −, $2E_{Na} = 50° \pm 10°$, $2V = 19° \pm 5°$ (measured), $\rho < \upsilon$ (extreme). X is normal to the cleavage ($= c$).

$$\alpha_{Li} = 2.41 \pm 0.02. \qquad \beta_{Li} = 2.50 \pm 0.02. \qquad \gamma_{Li} = 2.51 \pm 0.02.$$

PURPURITE.

1. Oxford County, Maine (Col. Roebling). Optically +, 2E = 80° ±, 2V = 38° ± (measured), dispersion very strong, as section nearly normal to an optic axis shows abnormal green interference colors. X is normal to the perfect cleavage. The indices of refraction vary about 0.03.

$$\beta = 1.92 \pm 0.02.$$

Birefringence about 0.04. Intensely pleochroic. X = grayish. Y = deep blood-red. Z = deep blood-red.

2. Peru, Maine (U. S. N. M. 16123). Optically +, 2V moderate, strongly pleochroic.

$$\alpha = 1.85 \pm 0.02. \qquad \beta = 1.86 \pm 0.02. \qquad \gamma = 1.92 \pm 0.02.$$

The indices of refraction vary ±0.06.

PYROAURITE.

Långban, Sweden (U. S. N. M. 84148). Colorless, basal plates. Perceptibly uniaxial, optically −.

$$\omega = 1.565 \pm 0.003.$$

Birefringence about 0.01 or perhaps a little less.

PYROCHLORE.

Ilmen Mountains, Miask, The Urals (U. S. N. M. 4359). Clean, isotropic grains.

$$n = 1.96 \pm 0.01.$$

PYROPHYLLITE.

Indian Gulch, Mariposa County, Calif. (U. of C.). Rather coarse, pale-green talclike spherulites. Cleavage pieces are long blades with X normal to the blades and Z parallel to the elongation. Extinction nearly or quite parallel. Optically −, 2E = 94° to 104°, 2V = 53° to 60° (measured), 2V = 59° (indices). Dispersion is slight and probably $\rho > v$.

$$\alpha = 1.552 \pm 0.003. \qquad \beta = 1.588 \pm 0.003. \qquad \gamma = 1.600 \pm 0.003.$$

PYROSMALITE.

Nordmark, Sweden (U. of C.). Hexagonal crystals, nearly colorless in section. Uniaxial −.

$$\omega = 1.675 \pm 0.003. \qquad \epsilon = 1.636 \pm 0.003.$$

PYRRHITE.

Azores (U. S. N. M., Shepard Coll. 146r). Reddish crystals. Isotropic.

$$n = 2.16 \pm 0.02.$$

Compare with Koppite (p. 97).

QUENSTEDTITE.

See Copiapite (p. 61).

QUETENITE.

Quetena, Caloma, Chile (Col. Roebling). Optically +, $2E = 50° \pm 5°$, $2V = 32° \pm 3°$ (measured), $\rho > v$ (rather strong). X (or Y) is nearly normal to the cleavage. Strongly pleochroic.

$\alpha = 1.530 \pm 0.003$; colorless. $\beta = 1.535 \pm 0.003$; colorless.
$\gamma = 1.582 \pm 0.003$; orange-yellow.

See Castanite (p. 53).

RAIMONDITE.

1. Province Huancom (Col. Roebling). Hexagonal plates, uniaxial—. Some are divided into six biaxial segments with a uniaxial border. 2V small.

$$\omega = 1.82 \pm 0.01.$$

Birefringence strong. This mineral is no doubt jarosite.

2. Laurium, Greece (U. S. N. M. 82629). Earthy. Very minute flakes, uniaxial—.

$$\omega = 1.867 \pm 0.01. \qquad \epsilon = 1.79 \pm 0.01.$$

This mineral is probably plumbojarosite. A determination of PbO on the impure mineral by R. C. Wells gave 23.8 per cent. Raimondite is a doubtful mineral.

RASPITE.

Broken Hill, New South Wales (U. S. N. M. 84439). Small lath-shaped crystals. Very soft. Very perfect cleavage parallel to lath face. Optically +, 2V nearly 0, crystals lying on lath face show parallel extinction and X′ is parallel to the length; an optic axis emerges on the edge of the microscope field across the laths.

$$\alpha = 2.27 \pm 0.02. \qquad \beta = 2.27 \pm 0.02. \qquad \gamma = 2.30 \pm 0.02.$$

As the crystals are tabular {100} and elongated *b*, with perfect cleavage {100}, the optic orientation is: $Y = b$, X is oblique to the normal to {100}.

REALGAR.

1. Rul Island, Wash. (U. of C.).

$\alpha_{Li}=2.48\pm0.02$. $\beta_{Li}=2.60\pm0.02$. $\gamma_{Li}=2.61\pm0.02$.

2. Kurdestan, Persia (U. of C.). Optically−, 2V small.

$\alpha_{Li}=2.46\pm0.02$. $\beta_{Li}=2.59\pm0.02$. $\gamma_{Li}=2.61\pm0.02$.

It decomposes in the sulphur-selenium melts unless heated carefully.

3. Allchar, Macedonia, Turkey (U. S. N. M. 83623). Optically−, $2V_{Li}=40°$ (indices), $\rho>v$ (very strong), dispersion of bisectrices very strong, pleochroic.

$\alpha_{Li}=2.46\pm0.01$; nearly colorless. $\beta_{Li}=2.59\pm0.01$; nearly colorless. $\gamma_{Li}=2.61\pm0.01$; pale golden yellow.

REDDINGITE.

Branchville, Conn. (W. T. Schaller). Optically+, 2E = 70° ±, 2V = 41° ± (measured), $\rho>v$ (rather strong).

$\alpha=1.651\pm0.003$. $\beta=1.656\pm0.003$. $\gamma=1.683\pm0.003$.

REMINGTONITE.

Lower California, Mexico (Princeton). Uniaxial−; the indices vary a little.

$\omega=1.80\pm0.01$. $\epsilon=1.55\pm0.02$.

RETZIAN.

Moss mine, Sweden (Col. Roebling). Optically+, 2V large, $\rho<v$ (weak), strongly pleochroic.

$\alpha=1.777\pm0.005$; colorless. $\beta=1.788\pm0.005$; pale yellowish brown. $\gamma=1.800\pm0.005$; reddish brown.

RHABDOPHANITE.

Salisbury, Conn. (Col. Roebling). Colorless fibers with positive elongation.

$\omega=1.654\pm0.003$. $\epsilon=1.703\pm0.003$.

RHODONITE.

1. Broken Hill, New South Wales (U. S. N. M. 92911). Optically−, 2V medium.

$\alpha=1.733$. $\beta=1.740$. $\gamma=1.744$.

2. Fowlerite, Franklin Furnace, N. J. (U. S. N. M. 86796). Optically +, 2V large.

$\alpha=1.726$. $\beta=1.730$. $\gamma=1.737$.

RIPIDOLITE.

Zlatoust, Siberia (U. S. N. M. 50035). Pale-green plates. Optically +, 2E = 46° to 58°, 2V = 28° to 36°, $\rho<\upsilon$ (slight), pleochroic in thick sections.

$\alpha=1.580\pm0.003$; pale green. $\beta=1.580\pm0.003$; pale green.
$\gamma=1.589\pm0.003$; colorless.

RISORITE.

Risor, Norway (Col. Roebling). In section light reddish brown and isotropic, n varies from less than 2.04 to more than 2.08, average about 2.05.

RIVAITE.

Vesuvius, Italy (Col. Roebling). A mass of bright-blue fibers. Under the microscope it is seen to be made up of two minerals in approximately equal amounts. One of these minerals is clear and isotropic and has an index of refraction of 1.513 ± 0.003. The other occurs in prisms embedded in the isotropic part. These prisms are optically −, 2V is small, and the elongation is positive. X is normal to the fibers and the extinction is parallel.

$\alpha=1.614\pm0.003$. $\beta=1.627\pm0.003$. $\gamma=1.628\pm0.03$.

These properties are not very different from those of wollastonite. A thin section might show more, but sufficient material for a section was not available.

ROEBLINGITE.

Franklin Furnace, N. J. (U. S. N. M. 84364). Very finely fibrous, elongation −, optically +, 2V small.

$\alpha=1.64\pm0.01$. $\beta=1.64\pm0.01$. $\gamma=1.66\pm0.01$.

ROEMERITE.

1. Atacama, Chile (U. S. N. M. 51520). Optically −, 2E = 86° ± 3°, 2V = 51° ± 2° (measured), 2V = 53° ± 3° (indices), $\rho>\upsilon$ (very strong). Dispersion of bisectrices marked and some sections show very abnormal interference colors.

$\alpha=1.524\pm0.003$. $\beta=1.571\pm0.003$. $\gamma=1.583\pm0.003$.

2. "Buckingite," Tierra Amarilla, Chile (Col. Roebling). Pinkish-brown vitreous crusts and crystals. Optically $-$, $2E=73° \pm 5°$, $2V=45° \pm 3°$ (measured), $\rho > v$ (strong), crossed very strong.

$\alpha=1.519 \pm 0.003$. $\beta=1.570 \pm 0.003$. $\gamma=1.580 \pm 0.003$.

In white light sections normal to Y and Z give sharp extinction; sections normal to X give no extinction but very abnormal interference colors.

ROEPPERITE.

Franklin Furnace, N. J. (J. H. U.). Optically $-$, $2V=77° \pm 5°$ (indices), $\rho > v$ (rather strong).

$\alpha=1.758 \pm 0.003$. $\beta=1.786 \pm 0.003$. $\gamma=1.804 \pm 0.003$.

ROMEITE.

1. Italy (W. T. Schaller). The crystals are divided into segments corresponding to the faces, and each of these segments shows twin lamellae parallel to the face (or at least the edge of the plates).

Probably optically $-$ and biaxial, but no satisfactory data could be obtained.

$\beta=1.87 \pm 0.01$.

Birefringence moderate to weak.

2. Brazil (W. T. Schaller). "Atopite." Similar to No. 1.

$n=1.83$ varies ± 0.01.

Birefringence weak.

ROSELITE.

Schneeberg, Saxony (U. S. N. M. 82403). Optically $+$, 2V moderate, $\rho < v$ (strong). X is normal to the cleavage, and the plane of the optic axes is across the twin lamellae. Extinction on cleavage about 3°. Successive zonal growths show somewhat different optical properties. Thick pieces are faintly pleochroic.

Y = pale rose-red. Z = nearly colorless.

$\beta=1.725 \pm 0.01$.

Birefringence about 0.01.

ROSENBUSCHITE.

1. Langesund Fjord, Norway (R. M. Wilke, of Palo Alto, Calif.). Cleavable, prismatic crystals. Colorless in section. Optically $+$, $2E=110° \pm 10°$, $2V=58° \pm 5°$ (measured), Z makes a considerable angle with the normal to the cleavage.

$\alpha=1.683 \pm 0.003$. $\beta=1.688 \pm 0.003$. $\gamma=1.712 \pm 0.003$.

2. Skudesundskjout, Langesund, Norway (Prof. Brögger, U. of Stockholm). Brown, radial needles. Optically +, 2E = 115° ±, 2V = 60° ± 5° (measured), very faintly pleochroic.

$\alpha = 1.682 \pm 0.003$; colorless. $\beta = 1.687 \pm 0.003$; pale yellowish.
$\gamma = 1.710 \pm 0.003$; pale yellowish.

ROWLANDITE.

Llano County, Tex. (U. S. N. M. 83324). In section colorless to very pale green and isotropic.

$n = 1.725 \pm 0.003$.

RUMPFITE.

St. Michael, Austria (U. S. N. M. 85189). Optically +, 2V nearly or quite 0, optic axis normal to scales.

$\beta = 1.587$.

Birefringence about 0.005.

RUTHERFORDINE.

Leukengule, Uruguru Mountains, Morogoro, German East Africa (U. S. N. M. 87362). Yellow cube. Minute, matted fibers. Pale yellow in section.

$\alpha = 1.72 \pm 0.01$. $\gamma = 1.80 \pm 0.01$.

SALMOITE.

See Spencerite (p. 135).

SALMONSITE.

Pala, Calif. (type material from W. T. Schaller). Optically + 2V very large, $\rho > v$ (strong), Z is parallel to the fibers. Rather strongly pleochroic. Not entirely homogeneous.

$\alpha = 1.655 \pm 0.005$; nearly colorless. $\beta = 1.66 \pm 0.01$.
$\gamma = 1.670 \pm 0.005$; orange-yellow.

SAMARSKITE.

1. Tres Piedras, N. Mex. (F. L. Hess). Isotropic and brown in color.

$n = 2.10 \pm$.

2. Asheville, N. C. Isotropic. In section dark brown and nearly opaque.

$n = 2.25 \pm 0.02$.

SAMIRÉSITE.

Madagascar (Prof. Lacroix). Golden-yellow, vitreous crystal with a dull outer part. The more vitreous part in section is nearly colorless and isotropic. In part clear and glassy, in part dull and clouded. The index of refraction ranges from 1.92 to 1.96 and is higher for the clouded part.

SAPONITE.

1. Banat, Hungary (J. H. U.). Optically −, nearly or quite uniaxial.

$$\beta = 1.55 \pm 0.01.$$

Birefringence rather strong.

2. Cooks Kitchen, Cornwall, England (Col. Roebling). Very minute fibers.

$$n = 1.56 \pm 0.01.$$

Birefringence about 0.01.

SARKINITE.

Harstig mine, Pajsburg, Sweden (U. S. N. M. 48819). Optically −, 2V very large, dispersion not observed. Z makes an angle of 43° ± to the elongation.

$$\alpha = 1.780 \pm 0.003. \qquad \beta = 1.793 \pm 0.003. \qquad \gamma = 1.802 \pm 0.003.$$

SASSOLITE.

Sasso, Italy (U. of C.). Optically −, 2V very small, dispersion imperceptible. X is nearly normal to the cleavage and plates.

$$\alpha = 1.340 \pm 0.005. \qquad \beta = 1.456 \pm 0.003. \qquad \gamma = 1.459 \pm 0.003.$$

SCHIZOLITE.

Kangerdluarsuk, Greenland (Harvard). Optically +, 2V rather large, $\rho < v$ (rather strong). Z is along the fibers.

$$\alpha = 1.631 \pm 0.003. \qquad \beta = 1.636 \pm 0.003. \qquad \gamma = 1.660 \pm 0.003.$$

SCHNEEBERGITE.

Schneeberg, Austrian Tyrol (W. T. Schaller).

$$n = 2.09.$$

Anomalous birefringence low.

SCHORLOMITE.

Magnet Cove, Ark. (U. S. N. M. 45263). Reddish brown in section and isotropic.

$$n = 1.98 \pm 0.02; \text{ variable.}$$

SCHROECKINGERITE.

1. Joachimsthal, Bohemia (Col. Roebling). Green-yellow coatings of minute, prismatic crystals. Optically $-$, $2E=70°\pm$, $2V=40°\pm$ (measured), $\rho > v$ (very strong).

The section normal to X is elongated and tabular and gives no extinction in white light but very abnormal interference colors, which are due to extreme crossed dispersion. The crossed dispersion is very striking in the interference figure, and when the mineral is so turned as to give a cross this cross is colored red in one pair of opposite segments and blue or violet in the other pair. Pleochroic.

$\alpha=1.658\pm0.003$; colorless. $\beta=1.687\pm0.003$.
$\gamma=1.690\pm0.003$; canary-yellow.

2. Joachimsthal (Col. Roebling). Labeled "Uranothallite" but probably the same as No. 1. Small yellow-green prismatic crystals. Lath-shaped crystals show lamellar twinning with the composition plane nearly or quite normal to the section and parallel to the elongation. The extinction on this section $Z_{Na}\wedge$lamellae$=41°\pm$; in white light there is no extinction, owing to the marked dispersion. X is inclined somewhat to the normal to this face. On breaking crystals the fragments tend to line on a face that shows sharp, parallel extinction with no dispersion. X is across the length of these crystals and Z (or Y) is much inclined to the normal of this cleavage. More abundant fragments lie on a face normal to X and show lamellar twinning and marked dispersion. One fragment showed two sets of twin lamellae at an angle of 44°.

Optically $-$, $2E_{Na}=110°\pm5°$, $2V_{Na}=57°\pm3°$ (measured), $\rho > v$ (strong). Crossed dispersion extreme. Pleochroic.

$\alpha=1.660\pm0.003$; colorless. $\beta=1.698\pm0.003$; canary-yellow.
$\gamma=1.706\pm0.003$; canary-yellow.

The properties of the two minerals are similar enough to make it nearly certain that they are the same or at least closely related species. A number of other specimens labeled "schroeckingerite" were examined, but they proved to be uranothallite, or some other uranium mineral. The above mineral does not fit any other species and is probably schroeckingerite. It occurs in prismatic crystals with monoclinic symmetry and cleavages {010} very perfect and {100} perfect. It shows lamellae twinning {100} $X=b$ and $Z\wedge c=41°\pm$.

SCHROETTERITE.

Tallenggraben (U. S. N. M. 93068). Isotropic and essentially homogeneous.

$n=1.584\pm0.003$.

SCHWARTZEMBERGITE.

San Rafael, Sierra Gordo, Bolivia (Col. Roebling). Optically –, 2V small; dispersion not noticed.

$\alpha_{Li} = 2.25 \pm 0.02$. $\beta_{Li} = 2.35 \pm 0.02$. $\gamma_{Li} = 2.36 \pm 0.02$.

SCORODITE.

1. Nassau, Germany (U. S. N. M., Shepard Coll. 1445). Very pale green, glassy crystals. The optical properties vary a little. Optically +, $2E = 124° \pm 10°$, $2V = 62° \pm 5°$ (measured), $\rho > v$ (rather strong).

$\alpha = 1.765 \pm 0.01$. $\beta = 1.774 \pm 0.01$. $\gamma = 1.797 \pm 0.01$.

2. Red Mountain, Colo. (U. S. N. M. 81190). Pale-greenish, very finely fibrous crusts.

$\beta = 1.785 \pm 0.005$.

Birefringence rather strong.

3. Laurium, Greece (U. S. N. M. 79166). Green crystals, octahedral in habit. Optically +, 2V moderate, $\rho > v$ (very strong).

$\beta = 1.790 \pm 0.005$.

Birefringence 0.03.

4. Laurium, Greece (U. of C.). Green crystals, octahedral in habit. Optically +, $2V = 70° \pm 5°$ (indices), $\rho > v$ (rather strong).

$\alpha = 1.784 \pm 0.003$. $\beta = 1.793 \pm 0.003$. $\gamma = 1.812 \pm 0.003$.

5. Marble Valley, Cornwall, England (U. of C.). Botryoidal coating of pale-green radiating fibers. Optical properties vary somewhat. Elongation +. Optically –, 2V very large, $\rho < v$ (strong).

$\gamma = 1.74 \pm 0.01$.

Birefringence 0.03 ±.

6. Black Pine, Idaho (collected by E. S. Larsen). (Contains Fe_2O_3, 34.02; Cr_2O_3, 0.32; P_2O_5, 4.80; As_2O_5, 44.40; $H_2O - 110°$ C., 5.08; $H_2O + 110°$ C., 12.25.) Leek-green botryoidal crusts made up of radiating fibers. Optically +, 2V medium, $\rho > v$ (strong), inclined extinction.

$\alpha = 1.738 \pm 0.005$. $\beta = 1.742 \pm 0.005$. $\gamma = 1.765 \pm 0.005$.

7. Cornwall, England (U. S. N. M., Shepard Coll. 1446). Fine bright-green crystals. Optically –, 2V nearly 90°; dispersion not perceptible.

$\alpha = 1.810 \pm 0.003$. $\beta = 1.880 \pm 0.005$. $\gamma = 1.925 \pm 0.005$.

8. Kuira, Bungo, Japan (U. S. N. M. 87137). Pale-green crystals. Optically +, $2V = 62° \pm 5°$ (indices), $\rho > v$ (strong).

$\alpha = 1.888 \pm 0.003$. $\beta = 1.895 \pm 0.003$. $\gamma = 1.915 \pm 0.003$.

The eight specimens labeled scorodite and described above probably represent four distinct species. Specimens 1 to 4 are probably the same species and differ only as much as would be expected from a small isomorphous replacement of some of the constituents. Specimen 6 is a scorodite in which a small amount of P_2O_5 replaces As_2O_5, and specimen 5 has similar optical properties. Specimens 7 and 8, however, are probably different minerals.

SENAITE.

Minas Geraes, Brazil (Col. Roebling). Nearly opaque.

$$n_{Li} = 2.50 \pm 0.03.$$

Birefringence low.

SERPENTINE.

1. Chrysotile asbestos, very low in iron. Grand Canyon, west of Grand Canyon post office, at Capt. Bass mine. Analyzed. Very pale buff, silky fibers. Probably optically + with large axial angle. X ⊥ cleavage, Z // elongation.

$$\alpha = 1.508 \pm 0.005. \qquad \beta = 1.512 \pm 0.005. \qquad \gamma = 1.522 \pm 0.005.$$

A thin section made in the ordinary way showed $\alpha = n$ of balsam $= 1.539 \pm 0.003$. This increase in the indices of refraction is probably due to loss of water on heating.

2. Thetford, Canada. Greenish, silky fibers. The fibers are smaller in cross section than are those of the Grand Canyon mineral. Optically +, 2V probably small, Z // elongation.

$$\alpha = 1.542 \pm 0.005. \qquad \gamma = 1.552 \pm 0.005.$$

3. Lowell, Vt. Greenish, silky fibers. The fibers are smaller in cross section than are those of the Grand Canyon mineral.

$$\alpha = 1.543 \pm 0.005. \qquad \gamma = 1.555 \pm 0.005.$$

SERPIERITE.

Laurium, Greece (U. S. N. M. 50084). Optically −, $2E = 59° \pm 3°$, $2V = 35° \pm 2°$ (measured), $\rho > v$ (strong). X is normal to the very perfect cleavage. Pleochroic.

$\alpha = 1.584 \pm 0.003$; very pale greenish, nearly colorless.
$\beta = 1.642 \pm 0.003$; deep greenish blue.
$\gamma = 1.647 \pm 0.003$; deep greenish blue.

SHATTUCKITE.

Bisbee, Ariz. (type, W. T. Schaller). Optically +, 2V very large, fibers showing X and Z give parallel extinction, section showing Y and Z shows a small extinction angle. The mineral is probably monoclinic, with $X = b$ and Z to c small. Pleochroic.

$\alpha = 1.752 \pm 0.005$; nearly colorless. $\beta = 1.782 \pm 0.005$; pale greenish blue. $\gamma = 1.815 \pm 0.005$; deeper greenish blue.

SICKLERITE.

Pala, Calif. (type, W. T. Schaller). Optically –, 2V rather large, $\rho > \upsilon$ (very strong). X is normal to a good cleavage and sections on this cleavage give good extinction in white light indicating little or no dispersion of the bisectrices. The mineral is probably orthorhombic. Strongly pleochroic.

$\alpha = 1.715 \pm 0.005$; deep reddish. $\beta = 1.735 \pm 0.005$; paler reddish.
$\gamma = 1.745 \pm 0.005$; very pale reddish.

SIDERONATRITE.

Sierra Gorda, Chile (U. S. N. M. 48947). Fibers with perfect cleavage parallel to the elongation. X is normal to this cleavage and Z is parallel to the elongation. Optically +, 2V = 58° ± 5° (indices), $\rho > \upsilon$ (strong). Pleochroic.

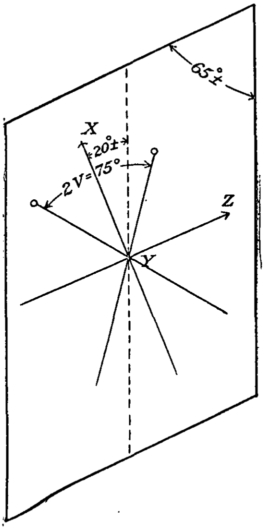

FIGURE 11.—Optical orientation of tablets {010} of artificial sodium bicarbonate.

$\alpha = 1.508 \pm 0.003$; nearly colorless.
$\beta = 1.525 \pm 0.003$; very pale amber-yellow.
$\gamma = 1.586 \pm 0.003$; pale amber-yellow.

A few of the fibers show γ about 1.595. The elongation may be taken as *c* and the cleavage as {100}, and the orientation becomes X = *a*, Y = *b*, Z = *c*.

SIDEROTIL.

1. Pale-greenish powder coating fresh melanterite from California. Optically –, 2V rather large, $\rho > \upsilon$ (easily perceptible).

$\alpha = 1.528 \pm 0.003$. $\beta = 1.537 \pm 0.003$.
$\gamma = 1.545 \pm 0.003$.

2. Alteration of artificial melanterite same as above.

SIPYLITE.

Amherst, Va. (U. S. N. M. 84388). Isotropic grains, pale brownish red in section.

n ranges from about 2.05 to 2.07.

SMITHITE.

See Trechmannite (p. 144).

SODIUM BICARBONATE.

Artificial "A. & H." baking soda. Optically –, 2V = 75° ± 2° (indices), $\rho > \upsilon$ (perceptible). In elongated rhombic plates with an angle of 65° between the sides. Y is normal to the plates and X $\wedge$ longer edge $= 20° \pm$ in the obtuse angle of the rhombs. Probably monoclinic, tabular {010}, Y = *b*.

$\alpha = 1.380 \pm 0.005$. $\beta = 1.500 \pm 0.003$. $\gamma = 1.586 \pm 0.003$.

SPADAITE.

Capo di Bove, Rome (Col. Roebling). The material is made up of wollastonite, calcite, and a mineral, probably spadaite, that is amorphous to submicroscopic in crystallization.

$n = 1.53 \pm 0.01$.

The material is not entirely satisfactory.

SPENCERITE.

Salmo, B. C. (type from Prof. Phillips). Colorless, pearly flakes. Optically $-$, $2E = 83° \pm 2°$, $2V = 49° \pm 2°$ (measured), $\rho > \upsilon$ (rather strong). X is normal to the plates and a perfect cleavage, and Y is parallel to the two cleavages.

$\alpha = 1.586 \pm 0.003$. $\beta = 1.600 \pm 0.003$. $\gamma = 1.602 \pm 0.003$.

Compare with Hibbenite (p. 85) and Hopeite, α (p. 252) and β (p. 251).

The mineral contains some spherulites of another mineral, probably an alteration product with + elongation, and a somewhat higher index of refraction.

There are also grains of a colorless mineral (salmoite) with the following properties:

Optically $-$, 2V moderately large, $\rho > \upsilon$ (perceptible).

$\alpha = 1.645 \pm 0.003$. $\beta = 1.683 \pm 0.003$. $\gamma = 1.695 \pm 0.003$.

SPHAERITE.

Cerhovitz, Bohemia (W. T. Schaller). Spherical masses of white fibers. Optically $-$, 2V large, extinction is parallel or nearly so, and Z is parallel to the elongation.

$\alpha = 1.562 \pm 0.003$. $\beta = 1.576 \pm 0.003$. $\gamma = 1.588 \pm 0.003$.

SPHAEROCOBALTITE.

Boleo, near Santa Rosa, Baja California (U. S. N. M. 83337). Uniaxial $-$, almost colorless in section. In general appearance resembles calcite.

$\omega = 1.855 \pm 0.005$. $\epsilon = 1.60 \pm 0.01$.

SPODIOSITE.

Wermland, Sweden (Col. Roebling). Optically +, $2V = 69° \pm 5°$ (indices), $\rho > v$ (rather strong). The cleavages are not normal to any of the principal optical directions. A fragment lying on one cleavage showed Z′ to trace of other cleavage 35° ±.

$\alpha = 1.663 \pm 0.003$. $\beta = 1.674 \pm 0.003$. $\gamma = 1.699 \pm 0.003$.

Probably triclinic.

STIBICONITE.

1. Kern County, Calif. (Cal. Min.). White, opaline material in concentric spheroidal shells. Under the microscope the grains are in part clear and glassy, in part clouded. All are distinctly isotropic.

n ranges from 1.605 to 1.63; average about 1.615.

2. Black Warrior mine, Jackson Canyon, 1½ miles south of Unionville, Nev. (F. L. Hess). Nearly homogeneous. Isotropic, in part clear, in part somewhat clouded.

$n = 1.647 \pm 0.005$.

3. Antimony, Garfield County, Utah (U. S. N. M. 77034). Alteration of stibnite. Chiefly clear, glassy, and isotropic.

$n = 1.69 \pm 0.01$.

Some cloudy, faintly birefracting fibers with + elongation.

$n = 1.67 \pm 0.01$.

4. No locality. Part of a large crystal of altered stibnite (U. of C.). In large part clear and isotropic.

n ranges from 1.720 to 1.740; averages 1.730.

Some indistinctly birefracting material.

5. No locality (U. of C.). Labeled "August Harding, 1880."

A. A botryoidal, glassy coating, which consists in part of fibrous crusts with + elongation.

Birefringence about 0.01. Consists in part of isotropic material.

$n = 1.77 \pm 0.01$.

B. Pale-yellow botryoidal crusts are similar to A. In the birefracting part

$n = 1.745 \pm 0.005$.

C. Pseudomorph after crystals of stibnite.

(*a*) In part cloudy and perceptibly isotropic.

$$n = 1.745 \pm 0.0005.$$

(*b*) In part clear and isotropic.

$$n = 1.71 \pm 0.01.$$

(*c*) In part birefracting fibers with + elongation.

n ranges from 1.71 to 1.75 but is chiefly about 1.72.

Birefringence about 0.01. The different substances occur in concentric layers.

6. Pima County, Ariz. (U. S. N. M. 80703). Chiefly isotropic but with incipient crystallization. The clear isotropic part has

$$n = 1.86 \pm 0.01.$$

Clouded grains have *n* up to 1.89.

7. Eureka district, Nev. (A. M. N. H.). Rather coarsely fibrous.

n ranges from 1.91 to 1.97 about.

Birefringence moderate.

See Cervantite (pp. 54–55).

TABLE 5.—*Optical data of stibiconite, cervantite, and related hydrous oxides of antimony.*

Isotropic types.

Specimens labeled stibiconite:	
Kern County, Calif.	1.605–1.63
Unionville, Nev.	1.640–1.65
Garfield County, Utah	1.68–1.70
Unknown locality	1.70–1.72
Do	1.72–1.74
Do	1.74–1.75
Specimens labeled stibiconite—Contd.	
Unknown locality	1.77
Pima County, Ariz.	1.85–1.87
Cervantite:	
Cornwall, England	1.86–1.90
Kern County, Calif.	1.97–1.99
Do	1.98–2.00

Birefracting types.

Specimens labeled stibiconite:	
Garfield County, Utah (birefringence low)	1.67±.01
Unknown locality (birefringence moderate)	1.71 to 1.75
Do	1.745
Do	1.77
Eureka district, Nev.	1.91 to 1.97
Cervantite:	
Western Australia (birefringence strong)	1.91
Fords Creek, New South Wales (birefringence rather strong)	1.98
Utah (birefringence indistinct)	2.05
Knoppenberg, Austria (birefringence faint)	2.06±0.02

The optical data show that the minerals commonly called stibiconite and cervantite differ greatly in optical properties and that no doubt they differ also in chemical composition. Certainly, more than two species are included in the material examined. Further connected optical and chemical study on this series is greatly needed. The preceding tables show the range of the optical properties of the specimens examined. The variation in single specimens is not usually greater than is shown in a large number of other minerals.

In the isotropic types there is an almost complete series of values for the index of refraction from 1.60 to 2.00. The data for the birefracting types are not so satisfactory, for nearly all were finely crystalline, and mixture with amorphous material may have given aggregate effects. However, there seem to be groupings about $n=1.75$, $n=1.95$, and $n=2.05$.

STILPNOMELANE.

1. Nassau, Germany (Col. Roebling). Perceptibly uniaxial, optically −, X normal to plates, strongly pleochroic.

$\omega=1.69\pm0.01$; dark brown, nearly opaque. $\epsilon=1.60\pm0.01$; yellowish.

2. Antwerp, N. Y. (U. of C.). Chalcodite. Nearly or quite uniaxial, optically −, pleochroic.

$\omega=1.76\pm0.01$; dark red-brown. $\epsilon=1.63\pm0.02$; pale yellowish.

3. North Carolina (F. A. Canfield). Chalcodite. Dark, red-brown, micaceous aggregates. Nearly uniaxial, optically −, Bx_a normal to the plates, strongly pleochroic.

$\alpha=1.65\pm0.01$; pale yellowish. β and $\gamma=1.78\pm0.01$; deep red-brown.

STOLZITE.

Broken Hill, New South Wales (U. S. N. M. 84439). Uniaxial −. $\omega=2.27\pm0.01$. $\epsilon=2.19\pm0.01$.

STRENGITE.

1. Near Giessen, Germany (U. S. N. M., Shepard Coll. 1109W). Pale pink crystals. Optically +, 2V very small, $\rho>v$ (strong). Fibers show positive elongation.

$\alpha=1.708\pm0.01$. $\beta=1.708\pm0.01$. $\gamma=1.745\pm0.01$.

2. Lexington, Va. (U. S. N. M. 46258). Pale-pink crystals. Optically +, $2E_{Na}=51°\pm2°$, $2V_{Na}=29°\pm1°$ (measured), $\rho<v$ (very strong). Crystals tend to lie on a face normal to Z.

$\alpha=1.730\pm0.003$. $\beta=1.732\pm0.003$. $\gamma=1.762\pm0.003$.

3. Stewart mine, Pala, Calif. (analyzed, W. T. Schaller). Blue fibers. Optically −, 2V moderate, pleochroic.

$\alpha = 1.697 \pm 0.005$; very pale violet. $\beta = 1.714 \pm 0.005$; violet.
$\gamma = 1.722 \pm 0.005$; deep blue.

4. Angelardite, La Vilate, France (Prof. Lacroix). Very finely crystalline. Pleochroic.

$\alpha = 1.710 \pm 0.005$. $\gamma = 1.730 \pm 0.005$.

STRIGOVITE.

Strigovan, Silesia (R. M. Wilke, of Palo Alto, Calif.). Hexagonal plates and fibers. Nearly or quite uniaxial and optically −. X is normal to the plates.

$$\alpha = 1.65 \pm 0.01.$$

Birefringence about 0.02. Strongly pleochroic. X = pale greenish. Y and Z = nearly opaque.

STRUEVERITE.

1. Salak North, Kwala Kangsar, Puab, Federated Malay States (Col. Roebling). Probably optically + (?), birefringence probably very strong. Very strongly pleochroic, brown in one direction and dark green and nearly opaque in the other.

$$n_{\mathrm{Li}} = 2.50 \pm 0.05.$$

2. Black Hills, S. Dak. (analyzed, F. L. Hess). Strongly pleochroic and too nearly opaque for good optical data. X is brown and Z is nearly opaque to greenish. Probably optically −, for no sections show the brown absorption in both directions, whereas many show the black.

$$\beta_{\mathrm{Li}} = 2.50 \pm 0.03.$$

Birefringence moderate.

SUCCINITE.

Baltic region (Col. Roebling). Isotropic.

$$n = 1.543 \pm 0.003.$$

SULPHOHALITE.

Borax Lake, Calif. (Col. Roebling). Isotropic.

$$n = 1.454 \pm 0.002.$$

SUSSEXITE.

Franklin Furnace, N. J. (U. of C.). Fibrous, optically +, Z parallel to elongation, probably orthorhombic.

$\alpha = 1.541 \pm 0.003$. $\beta = 1.545 \pm 0.003$. $\gamma = 1.554 \pm 0.003$.

SVABITE.

Pajsberg, Sweden (Col. Roebling). Uniaxial −.

$\omega = 1.706 \pm 0.003$. $\epsilon = 1.698 \pm 0.003$.

SYMPLESITE.

Lobenstein, Voigtland, Germany (A. M. N. H.). Blue fibers. Optically −, $2H = 97° \pm 1°$, $2V = 86\frac{1}{2}° \pm 1°$ (measured on Federow stage), $\rho > v$ (rather strong). The fibers tend to lie on a face or cleavage normal to X, and this section gives an extinction angle $Z \wedge$ elongation $= 31\frac{1}{2}° \pm 1°$. Fibers turned at 90° to this show parallel extinction. Strongly pleochroic.

$\alpha = 1.635 \pm 0.005$; deep blue. $\beta = 1.668 \pm 0.003$; nearly colorless. $\gamma = 1.702 \pm 0.003$; yellowish.

SYNADELPHITE.

Nordmark, Sweden (U. S. N. M. 84351). Optically +, 2V small, faintly pleochroic in dark reddish brown.

$\alpha = 1.86 \pm 0.01$. $\beta = 1.87 \pm 0.01$. $\gamma = 1.90 \pm 0.01$.

SZMIKITE.

1. Artificial ($MnSO_4.H_2O$). Optically +, 2V near 90°.

$\alpha = 1.562 \pm 0.003$. $\beta = 1.595 \pm 0.003$. $\gamma = 1.632 \pm 0.003$.

2. Felsöbânya, Hungary (A. M. N. H.). Minute grains or crystals with − elongation. It appears to be monoclinic, with $Z = b$ and extinction on $\{010\}$ large.

$\alpha = 1.57 \pm 0.01$. $\gamma = 1.62 \pm 0.01$.

TAGILITE.

1. Nizhni Tagilsk, Russia (Col. Roebling). Very fine fibers with − elongation. Optically −, 2V small.

$\alpha = 1.69 \pm 0.01$. $\beta = 1.84 \pm 0.01$. $\gamma = 1.85 \pm 0.01$.

2. Moravico, Banat (Col. Roebling). Labeled "Veszelyite." Greenish-blue spherulitic fibers. Optically −, 2V near 0; X is parallel to the elongation.

$\alpha = 1.685 \pm 0.005$. β and $\gamma = 1.82 \pm 0.005$.

This mineral is probably tagilite. The data are more accurate than those for No. 1, as the material is coarser.

3. See Langite (No. 1) (p. 97).

TAMARUGITE.

1. Cerros Pintados, Tarapacá, Chile (Col. Roebling). Mass of colorless fibers. Optically +, $2E = 95° \pm 1°$, $2V = 59° \pm 1°$ (measured), dispersion not noticed. Some fragments show polysynthetic twin lamellae with small symmetrical extinction (Z to lamellae), other fibers show rather large extinction angles.

$\alpha = 1.484 \pm 0.003$. $\beta = 1.487 \pm 0.003$. $\gamma = 1.496 \pm 0.003$.

2. Box Elder, Utah. See Mendozite (p. 108).

3. Artificial. See Mendozite (p. 109).

TANTALITE.

See Columbite (p. 59).

TAPIOLITE.

Haute-Vienne, France (U. S. N. M. 86267). Uniaxial +, very strongly pleochroic. Specific gravity, 7.4.

$\omega_{Li} = 2.27 \pm 0.01$; pale yellowish or reddish brown.
$\epsilon_{Li} = 2.42 \pm 0.05$; nearly opaque.

Compare with Tantalite and Columbite (p. 59).

TARAMELLITE.

Italy (Col. Roebling). Optically +, $2E = 69° \pm 5°$, $2V = 40° \pm 3°$ (measured), $\rho > v$ (strong). X is normal to the plates. The pleochroism is marked.

$\alpha = 1.770 \pm 0.003$; pale pinkish, nearly colorless.
$\beta = 1.774 \pm 0.003$; pale pinkish, nearly colorless.
$\gamma = 1.83 \pm 0.02$; nearly opaque.

TARBUTTITE.

Broken Hill, Bone Cave, Rhodesia (U. S. N. M. 86662). Optically −, $2E = 82° \pm 5°$, $2V = 50° \pm 3°$ (measured). Dispersion of the bisectrices is strong. The dispersion of the optic axis is not great, as one bar shows red on the concave side, the other on the convex side.

$\alpha = 1.660 \pm 0.003.$ $\beta = 1.705 \pm 0.003.$ $\gamma = 1.713 \pm 0.003.$

TAVISTOCKITE.

Cornwall, England (A. M. N. H.). White spherulites attached to a rock. Optically +, $2V = 74° \pm 5°$ (indices). Dispersion not perceptible. Y emerges from the cleavage plates, Z is parallel to the elongation.

$\alpha = 1.522 \pm 0.003.$ $\beta = 1.530 \pm 0.003.$ $\gamma = 1.544 \pm 0.003.$

TAYLORITE.

Guanape, Peru (A. M. N. H.). Optically +, $2E = 54° \pm 3°$, $2V = 36° \pm 2°$ (measured), $\rho > v$ (rather strong).

$\alpha = 1.447 \pm 0.003.$ $\beta = 1.448 \pm 0.003.$ $\gamma = 1.459 \pm 0.003.$

TELLURITE.

Boulder County, Colo. (Col. Roebling). Nearly colorless plates with a very perfect cleavage and adamantine luster. X is normal to the cleavage. Probably optically +, $\rho < v$ (moderate), but 2V is so nearly 90° that the test was uncertain.

$\alpha_{Li} = 2.00 \pm 0.05.$ $\beta_{Li} = 2.18 \pm 0.02.$ $\gamma_{Li} = 2.35 \pm 0.02.$

TENGERITE.

Ytterby, Sweden (J. H. U.). White coating, in large part fibers and crystal aggregates, in part it may be amorphous. The crystals are optically +, 2V is large, and X is parallel to the elongation.

$\alpha = 1.555 \pm 0.003.$ $\gamma = 1.585 \pm 0.003.$

TENNANTITE.

Arizona (U. of C.). Isotropic. Translucent only in the thinnest edges of splinters.

$n_{Li} > 2.72.$

TENORITE.

Vesuvius, on lava of August, 1875 (U. S. N. M. 13607). Long, lath-shaped crystals which show twinning with the composition plane parallel to the long edge. X, which is probably the Bx_a, is oblique to the normal to the plates. On these plates the extinction is X′ to the composition plane $= 35° \pm$. Very strongly pleochroic. Absorption $Z >> X$. Z is nearly opaque.

n is extreme. The birefringence is probably not extreme, although the thickness of the plates is uncertain.

TEPHROITE.

Franklin Furnace, N. J. (U. of C.). Optically −, 2V = large, $\rho > v$ (perceptible). Nearly colorless in section.

$\alpha = 1.770 \pm 0.003$. $\beta = 1.792 \pm 0.003$. $\gamma = 1.804 \pm 0.003$.

TERLINGUAITE.

Terlingua, Tex. (U. S. N. M. 86645). Optically −, $2E_{red} = 57° \pm 3°$, $2V_{red} = 20° \pm 2°$ (measured), $\rho < v$ (extreme). Some sections show no extinction in white light but abnormal interference colors near the position of extinction. Crystals lie on a cleavage face which shows the emergence of X beyond the edge of the field of the microscope.

$\alpha_{Li} = 2.35 \pm 0.02$ $\beta_{Li} = 2.64 \pm 0.02$. $\gamma_{Li} = 2.66 \pm 0.02$.

TETRAHEDRITE.

Kapnik, Hungary (U. of C.). Nearly opaque. Reddish on thin edges of splinters. Isotropic.

$n_{Li} > 2.72$.

THENARDITE.[33]

Searles Lake, Calif. Optically +, 2V nearly 90°, $\rho > v$ (perceptible).

$\alpha = 1.464 \pm 0.003$. $\beta = 1.474 \pm 0.003$. $\gamma = 1.485 \pm 0.003$.

THERMONATRITE.

1. Artificial. Optically −, 2E = 77° (measured), 2V = 48° ± 3°; 2V = 48° (indices) $\rho < v$ (slight).

$\alpha = 1.420$. $\beta = 1.506$. $\gamma = 1.524$.

In pointed laths, with Y normal to flat face and X parallel to the length.

2. Several specimens that were labeled "thermonatrite" proved to be trona.

THORIANITE.

Ceylon (U. S. N. M. 87691). Isotropic. Translucent only on the thinnest edges.

n varies somewhat but averages about 2.20.

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[33] Görgy, R., Zur Kenntnis der Minerale der Salzlagerstätten: Min. pet. Mitt., vol. 29, p. 202, 1910.

THORITE.

1. Orangite. Landbö, Norway (A. M. N. H.). Isotropic, very pale yellow in section.

$$n = 1.683 \pm 0.003.$$

On ignition over a blast lamp for half an hour it became darker and clouded but remained isotropic.

$$n = 1.78 \pm 0.01 \text{ (varied)}.$$

2. Brevik, Norway (U. S. N. M. 49016). Orange-yellow, a little darker than No. 1. Isotropic.

$$n = 1.693 \pm 0.003.$$

3. Langesund Fiord, Norway (R. M. Wilke, of Palo Alto, Calif.). Dark brownish-black vitreous crystals. In section partly nearly colorless $n = 1.68 \pm 0.01$, partly reddish brown with variable n, which in some grains is above 1.72. Isotropic in large part; some of the material indistinctly fibrous.

4. Langesund Fiord, Norway (U. S. N. M. 87367). Dark-brownish vitreous fragments. In section reddish brown and perceptibly isotropic.

$$n = 1.686 \pm 0.005.$$

On ignition over a blast lamp for half an hour it became clouded and dusted with dark specks. In part isotropic. $n = 1.85 \pm$. In part birefracting. Uniaxial +.

$$\omega = 1.84 \pm 0.01.$$

Birefringence about 0.01.

TRECHMANNITE.

Binnenthal, Switzerland (U. S. N. M.). Cochineal red. Faintly pleochroic.

ω = pale reddish. ϵ = clear and nearly colorless.

Uniaxial −. Birefringence extreme. On heating in sulphur-selenium melts it inverts to a biaxial form, probably smithite, with the following properties. Optically −, 2V moderate, $\rho > v$ (strong).

$$\alpha_{Li} = 2.48 \pm 0.02. \qquad \beta_{Li} = 2.58 \pm 0.02. \qquad \gamma_{Li} = 2.60 \pm 0.02.$$

TRICHALCITE.

Turginsk, Urals (Col. Roebling). Green plates. In section pale bluish green and nonpleochroic. X is normal to the plates and Y is parallel to the elongation. The mineral is probably orthorhombic. Optically −, 2V large.

$\alpha = 1.67 \pm 0.01$. $\beta = 1.686 \pm 0.003$. $\gamma = 1.698 \pm 0.003$.

TRIPLOIDITE.

Branchville, Conn. (U. S. N. M.). Y is nearly normal to the cleavage plates, $X = b$, $Z \wedge c$ is small. Optically +, 2V moderate, $\rho > \upsilon$ (extreme). Dispersion of bisectrices marked.

$\alpha = 1.725 \pm 0.003$. $\beta = 1.726 \pm 0.003$. $\gamma = 1.730 \pm 0.003$.

TRIPPKEITE.

Copiapo, Chile (Col. Roebling). Blue-green crystals, which break up along the perfect prismatic cleavages into flexible asbestos-like fibers. Under the microscope they are pale blue-green in transmitted light and not perceptibly pleochroic. The elongation is positive. Uniaxial +.

$\omega = 1.900 \pm 0.01$. $\epsilon = 2.12 \pm 0.01$.

TRIPUHYITE.

Tripuhy, Brazil (Col. Roebling). Greenish-yellow grains. Optically +, 2V small, $\rho < \upsilon$ (very strong).

$\alpha = 2.19 \pm 0.01$. $\beta = 2.20 \pm 0.01$. $\gamma = 2.33 \pm 0.01$.

TRITOMITE.

1. Brevik, Norway (A. M. N. H.). Pale brownish yellow in section and sensibly isotropic.

n varies from 1.73 to 1.75.

2. Langesund Fiord, Norway (Yale, B. Coll. xx 4178). Pale pink in section and isotropic.

$n = 1.757 \pm 0.005$; nearly or quite homogeneous.

3. Brevik, Norway (Col. Roebling). Brownish in section and isotropic.

$n = 1.74 \pm 0.01$.

TROEGERITE.

1. Schneeberg, Weisser Hirsch mine at Neustädtel, Saxony. With zeunerite. Pale lemon-yellow plates. Optically −, 2V very small, X normal to the plates.

$\alpha = 1.585 \pm 0.005$. $\beta = 1.630 \pm 0.005$. $\gamma = 1.630 \pm 0.005$.

There are also fibers which tend to lie on a face normal to X and have Z parallel to the elongation. Optically −, 2V moderate to small, $\rho < v$ (very strong).

$$\beta = 1.665 \pm 0.005.$$

Birefringence strong.

This mineral no doubt is uranophane.

2. Schneeberg, Germany (U. S. N. M., Shepard Coll. 144). Orange-yellow powder. Plates that are sensibly uniaxial and optically −. No dispersion perceptible. ϵ is normal to the plates.

$$\omega = 1.624 \pm 0.003. \qquad \epsilon = 1.580 \pm 0.005.$$

TRONA.

1. Searles Lake, Calif. Optically −, 2V = 72° ± 5° (indices), $\rho < v$ (rather strong). Z nearly normal to the perfect cleavage.

$$\alpha = 1.410 \pm 0.003. \qquad \beta = 1.492 \pm 0.003. \qquad \gamma = 1.542 \pm 0.003.$$

2. Vesuvius, Italy (U. S. N. M. 85166). Labeled "thermonatrite." Optically −, 2V = 72° ± 5° (indices). Lath-shaped crystals, in which X is parallel to the elongation, Y is normal to the flat face, and Z is normal to the thin face.

$$\alpha = 1.413 \pm 0.005. \qquad \beta = 1.492 \pm 0.003. \qquad \gamma = 1.538 \pm 0.003.$$

TSCHEFFKINITE.

1. Nelson County, Va. (U. S. N. M. 47569). In section reddish brown with much opaque black material along cracks. In part isotropic and in part strongly birefracting and pleochroic. Probably an alteration product.

2. Bedford County, Va. (Yale, B. Coll. 5687). In part isotropic, with $n = 1.880$. In part red-brown and birefracting. Optically −, 2V moderate. Pleochroic. X = nearly colorless; Y = pale red-brown; Z = rather dark red-brown.

$$\beta = 1.880 \pm 0.005.$$

Birefringence about 0.01.

The properties are somewhat variable.

3. Madagascar (Prof. Lacroix). Black, vitreous mineral with conchoidal fracture traversed by dull brownish streaks, probably due to alteration. The black, vitreous part was used for optical data. In part isotropic and red-brown in section.

$$n = 1.965 \pm 0.01 \text{ (varies a little).}$$

In part optically−, 2V small, strongly pleochroic in red-brown with absorption $Z>X$.

$$\beta=1.97\pm0.01 \text{ (varies a little).}$$

Birefringence 0.02±.

TSUMEBITE.

Tsumeb, Otavi, German Southwest Africa (Col. Roebling). Optically+, 2V near 90°, $\rho<v$ (strong), faintly pleochroic, absorption $Z>X$.

$\alpha=1.885\pm0.005$. $\beta=1.920\pm0.005$. $\gamma=1.956\pm0.005$.

TUNGSTITE.

Salmo, B. C. (W. T. Schaller). Optically−, 2V rather small, $\rho<v$ (rather strong). Some material shows rather strong absorption $Z>Y>X$.

$\alpha=2.09\pm0.02$. $\beta=2.24\pm0.02$. $\gamma=2.26\pm0.02$.

TURGITE.

1. Salisbury, Conn. (U. S. N. M. 18330). Black fibers with a red streak. Optically−, 2V small. X parallel to the elongation. Absorption faint $Z>X$.

$\alpha_{Li}=2.50\pm0.02$. β_{Li} and $\gamma_{Li}=2.60\pm0.02$.

2. Salisbury, Conn. (A. M. N. H.). Fibers with −elongation. Optically−, 2V small.

$\alpha_{Li}=2.40\pm0.02$. β_{Li} and $\gamma_{Li}=2.50\pm0.02$.

TYROLITE.

Mammoth mine, Tintic district, Utah (U. of C.). Pale-green crystals and plates. Optically−, $2E=65°\pm5°$, $2V=36°\pm3°$ (measured), $\rho>v$ (strong). Lath-shaped crystals, with X normal to the laths and Y parallel to the elongation. Pleochroic.

$\alpha=1.694\pm0.003$; pale grass-green. $\beta=1.726\pm0.003$; pale yellowish green. $\gamma=1.730\pm0.003$; pale grass-green.

TYSONITE.

Cheyenne Mountain, near Pikes Peak, Colo. (U. S. N. M. 84413). Uniaxial−, the basal cleavage is not prominent.

$\omega=1.611\pm0.003$. $\epsilon=1.605\pm0.003$.

TYUYAMUNITE.

1. Siberia (F. L. Hess). Very finely fibrous. Optically −, 2V = moderate, X normal to the plates.

$$\beta = 1.87 \pm 0.01.$$

Birefringence very strong.

2. Red Creek, Browns Park, Uinta County, Utah (F. L. Hess). The material occurs in minute but well-developed plates in rude, elongated rhombs. X is normal to the plates, and Y is parallel to the long edge of the rhombs. The mineral is orthorhombic. Optically −, 2E = 70° ± 3°, 2V = 36° ± 2° (measured), 2V = 36° (indices), $\rho < v$ (rather strong), pleochroic.

$\alpha = 1.670 \pm 0.01$; nearly colorless.
$\beta = 1.870 \pm 0.005$; canary-yellow.
$\gamma = 1.895 \pm 0.005$; canary-yellow, slightly deeper than Y.

Compare with Carnotite (p. 52).

ULEXITE.

1. California (U. of C.). Optically +, 2V moderate, X is sensibly normal to the fibers, Y makes an angle of about 23° with the fibers. Probably monoclinic, with X = *b*.

2. Columbus Marsh, Nev. (F. L. Hess). The usual woolly balls. Optically +, 2V large, X is sensibly normal to the fibers. Y makes an angle of 22° ± with the fibers, but this extinction angle appears to vary considerably.

$\alpha = 1.491 \pm 0.003$. $\beta = 1.504 \pm 0.003$. $\gamma = 1.521 \pm 0.003$.

3. Teheran, Persia (U. S. N. M. 46215). Minute fibers in which Y is perceptibly parallel to elongation or makes a small extinction angle. Probably optically + with large 2V.

$\alpha = 1.491 \pm 0.003$. $\beta = 1.504 \pm 0.003$. $\gamma = 1.520 \pm 0.003$.

4. Hayesine. Tarapacá, Chile (U. S. N. M. 81705). Minute fibers in which Y is perceptibly parallel to the elongation.

$\alpha = 1.491 \pm 0.003$. $\beta = 1.503 \pm 0.003$. $\gamma = 1.520 \pm 0.003$.

The specimens of hayesine from Tarapacá in the museums of Johns Hopkins and Princeton universities are similar but show extinction angles of 24° and 20°. See Bechilite (p. 45).

$\alpha = 1.495 \pm 0.003$. $\beta = 1.508 \pm 0.003$. $\gamma = 1.520 \pm 0.003$.

URACONITE (?).

Gilpin County, Colo. (U. S. N. M. 85007). Lemon-yellow powder. Very finely crystalline and nearly homogeneous. Made up of minute fibers and imperfect laths which show perceptibly parallel extinction, positive elongation, and X perceptibly normal to the laths. Optically +, 2V medium, $\rho < v$ (strong).

$\alpha = 1.75 \pm 0.01$. $\beta = 1.79 \pm 0.01$. $\gamma = 1.85 \pm 0.01$.

Probably orthorhombic laths. If the elongation is c and the flat face $\{100\}$, then $Z = c$, $Y = b$, and $X = a$.

URANOCHALCITE.

Johanngeorgenstadt, Saxony (U. S. N. M. 85178). Grass-green coating. Minute, intermatted fibers with positive elongation and abnormal interference colors. Optically +, 2V small. Very pale colored and faintly pleochroic.

$\alpha = 1.655$; very pale yellowish green.
$\gamma = 1.662$; pale greenish yellow.

The material is too finely crystalline for satisfactory data.

URANOCIRCITE.

Falkenstein, Saxony. Yellow-green plates. Optically −, 2V small, X normal to the plates, faintly pleochroic.

$\alpha = 1.610 \pm 0.003$; nearly colorless.
β and $\gamma = 1.623 \pm 0.003$; pale canary-yellow.

The plates show two sets of twin lamellae at right angles to each other.

URANOPHANE.

1. Silesia (U. S. N. M. 86707). Optically −, 2V small, $\rho < v$ (marked), Z is parallel to the length of the fibers.

$\alpha = 1.643 \pm 0.003$. $\beta = 1.667 \pm 0.003$. $\gamma = 1.670 \pm 0.003$.

2. Schneeberg, Saxony (Col. Roebling). Lemon-yellow needles. Optically −, $2E_{Na} = 54° \pm 5°$, $2V_{Na} = 32° \pm 3°$ (measured), $\rho < v$ (extreme), Z parallel to elongation, flat face or cleavage normal to X, pleochroic.

$\alpha = 1.645 \pm 0.005$; nearly colorless.
$\beta = 1.665 \pm 0.003$; pale canary-yellow.
$\gamma = 1.667 \pm 0.003$; canary-yellow.

3. Neustadt, near Schneeberg, Saxony (U. S. N. M. 84658). Similar in general character to the others.

$\alpha = 1.642 \pm 0.003$. $\beta = 1.666 \pm 0.003$. $\gamma = 1.670 \pm 0.003$.

URANOPILITE.

1. Joachimsthal, Bohemia (U. S. N. M. 84651). Orange-yellow powder made up of minute laths and fibers. Pale-yellow in section and not perceptibly pleochroic. Optically +, $2V_{Na}$ rather large, $\rho < v$ (extreme) and 2V for some colors of light is 0. Crystals that lie on the flat face show the emergence of X inclined to the normal to the plates and give rather sharp extinction in white light with Y to elongation 15° ± 2°. The crystals also tend to lie on a face nearly normal to an optic axis, in which position they give very abnormal interference colors. In other positions the crystals give large extinction angles with very abnormal interference colors and no extinction in white light. The optic plane is across the laths.

$\alpha = 1.621 \pm 0.003$. $\beta = 1.623 \pm 0.003$. $\gamma = 1.631 \pm 0.003$.

The mineral is probably triclinic.

The material contains some gypsum and another fibrous yellow mineral which has the following properties: Optically +, 2V small, $\rho < v$ (moderate) (?). Y is perceptibly parallel to the elongation and X is normal to a flat face.

$\alpha = 1.68$. $\beta = 1.71$.

These data do not agree with those of any of the known uranium minerals.

2. See Zippeite (p. 160).

URANOSPHAERITE.

Schneeberg, Saxony (Col. Roebling). Orange-yellow fibrous spherulites. Optically +, 2V very large, $\rho < v$ (strong). X is normal to a cleavage; Z is parallel to the elongation.

$\alpha = 1.955 \pm 0.01$. $\beta = 1.985 \pm 0.01$. $\gamma = 2.05 \pm 0.01$.

Probably orthorhombic. If the elongation is called c and the cleavage $\{100\}$ the optical orientation becomes $X = a$, $Y = b$, $Z = c$.

URANOSPINITE.

1. Schneeberg, Saxony (Col. Roebling). Pale greenish-yellow scales. Under the microscope these scales are seen to be well-formed, rectangular tablets with faces beveling each of the four edges. They are made up of three different zones. A small green core (A) is present in a few of the crystals and is rather sharply

separated from the rest. It has the form of the main crystal. The main part (B) is yellow and has a moderate axial angle. The border (C), which is not invariably present, is yellow and has a very small axial angle.

A. The green core has the following optical properties: Optically −, sensibly uniaxial. X is normal to the plates, pleochroic.

$\omega = 1.635 \pm 0.003$; clear, pale green. $\epsilon = 1.615 \pm 0.003$; very pale clouded green.

This mineral is probably zeunerite.

B. The main part has the following properties: Optically −, $2E = 78° \pm 2°$, $2V = 46° \pm 1°$ (measured), $\rho > v$ (rather strong). X is normal to the plates and Z is parallel to the elongation. Rather strongly pleochroic.

$\alpha = 1.560 \pm 0.003$; nearly colorless. $\beta = 1.582 \pm 0.003$; pale canary-yellow. $\gamma = 1.587 \pm 0.003$; pale canary-yellow.

C. The border has the following properties: Perceptibly uniaxial, optically −. ϵ is normal to the plates, pleochroic.

$\omega = 1.586 \pm 0.003$; pale yellowish. $\epsilon = 1.56 \pm 0.01$; nearly colorless.

It seems probable that the core is the copper compound zeunerite, the main part is the orthorhombic form of uranospinite, and the border is the tetragonal form of uranospinite, which is an inversion product from the orthorhombic form.

2. Schneeberg, Saxony (F. A. Canfield). With troegerite and walpurgite. Lemon-yellow cleavable crystals, bordering and crystallographically continuous with an emerald-green mineral (zeunerite?). Bx_a is normal to the perfect cleavage. Optically −, $2E = 100° \pm 5°$, $2V = 62° \pm 3°$ (measured), $\rho > v$ (rather strong). Rather strongly pleochroic.

$\alpha = 1.55 \pm 0.01$; colorless. $\beta = 1.567 \pm 0.003$; pale yellow. $\gamma = 1.572 \pm 0.003$; pale yellow.

URANOTHALLITE.

1. Joachimsthal, Bohemia (Col. Roebling). Yellowish-green crust. Colorless in section. Optically +, $2E = 65° \pm 3°$, $2V = 42° \pm 2°$ (measured), $\rho > v$ (moderate).

$\alpha = 1.500 \pm 0.003$. $\beta = 1.503 \pm 0.003$. $\gamma = 1.539 \pm 0.003$.

2. Joachimsthal, Bohemia (U. S. N. M. 52057). Optically +, $2E = 64° \pm 3°$, $2V = 41° + 2°$ (measured), $\rho > v$ (moderate). X is normal to a cleavage.

$\alpha = 1.498 \pm 0.003$. $\beta = 1.502 \pm 0.003$. $\gamma = 1.535 \pm 0.003$.

3. Schneeberg, Saxony (U. S. N. M. 45643). "Liebigite." Optically +, 2E = 57° + 5°, 2V = 37° ± 3° (measured), $\rho > v$ (perceptible).

$\alpha = 1.501 \pm 0.003$. $\beta = 1.503 \pm 0.003$. $\gamma = 1.537 \pm 0.003$.

4. Schneeberg (Yale, B. Coll. 2.995). "Liebigite." Optically +, 2V rather small. Lies on face normal to X.

$\beta = 1.505 \pm 0.003$.

Birefringence strong.

5. Joachimsthal, Bohemia (A. M. N. H.). "Liebigite." Optically +, 2V small, $\rho > v$ (perceptible).

$\beta = 1.505 \pm 0.005$.

Birefringence strong.

6. Joachimsthal, Bohemia (Col. Roebling). Labeled "Voglite." Optically +, 2V small, $\rho > v$ (perceptible).

$\alpha = 1.499 \pm 0.003$. $\beta = 1.501 \pm 0.003$. $\gamma = 1.540 \pm 0.003$.

If any reliance can be placed on the labeling of the specimens it is evident that liebigite and uranothallite are identical.

URBANITE.

Långban, Sweden (Mr. Holden). Optically +, 2V large, $\rho < v$ (perceptible). Nearly colorless in section.

$\alpha = 1.679 \pm 0.003$. $\beta = 1.688 \pm 0.003$. $\gamma = 1.710 \pm 0.003$.

See Aegirite-augite (p. 225).

UTAHITE.

Eureka Hill mine, Tintic, Utah (U. S. N. M. 48241). Hexagonal plates. Uniaxial −, indices of refraction somewhat variable.

$\omega = 1.82 \pm 0.01$.

Birefringence strong. This mineral is probably jarosite.

VALENTINITE.

Algiers (U. of C.). Fibrous. Optically −, 2V small, the blue part of the interference figure crosses, $\rho < v$ (marked), Z is parallel to the elongation.

$\alpha = 2.18 \pm 0.01$. β and $\gamma = 2.35 \pm 0.02$.

VARISCITE.

Lucin, Utah (analyzed by W. T. Schaller). Emerald-green, prismatic, tabular crystals. In powder nearly colorless, no cleavage noticed. Optically +, 2E = 93° ± 5°, 2V = 55° ± 3° (measured), $\rho < v$ (perceptible).

$\alpha = 1.551 \pm 0.003$. $\beta = 1.558 \pm 0.003$. $\gamma = 1.582 \pm 0.003$.

Y is normal to the plates and Z is parallel to the elongation. Hence X = *a*, Y = *b*, and Z = *c*.

VASHEGYITE.

Vashegy, Hungary (Col. Roebling). Minute fibers with + elongation.

$\beta = 1.48 \pm 0.01$.

Birefringence about 0.02.

Compare with Fischerite (p. 75) and Evansite (p. 172).

VAUQUELINITE.

Berezov, Siberia (Col. Roebling). Brownish green, fibrous crusts. Optically −, 2V near 0, X is parallel to the fibers. In part nearly colorless, in part pleochroic.

$\alpha = 2.11 \pm 0.02$; pale green β and $\gamma = 2.22 \pm 0.02$; pale brown.

VESZELYITE.

1. Dognacska, Bohemia (A. M. N. H.). Greenish-blue crystals, rudely octahedral in habit. In section pale greenish blue and not perceptibly pleochroic. Optically +, $2V = 71° \pm 5°$ (indices), $\rho < v$ (very strong). Dispersion of bisectrices not noticed.

$\alpha = 1.640 \pm 0.003$. $\beta = 1.658 \pm 0.003$. $\gamma = 1.695 \pm 0.003$.

2. Morawitza, Banat (Col. Roebling). This specimen is probably tagilite. For optical data see Tagilite (p. 141).

VIVIANITE.

Mullica Hill, N. J. (U. S. N. M. 79967). Optically +, $2V = 85° \pm 3°$ (indices), dispersion of bisectrices considerable. X is normal to perfect cleavage, intensely pleochroic.

$\alpha = 1.579 \pm 0.003$; very deep blue. $\beta = 1.603 \pm 0.003$; nearly colorless. $\gamma = 1.633 \pm 0.003$; very pale olive-green or brownish.

The data commonly given are inconsistent, as a mineral with $\gamma = 1.6267$, $\beta = 1.6050$, $\alpha = 1.5766$ would be optically −, with $2V = 81°$. The data of Rosicky[33] agree with those of the author except that Rosicky's data for the indices of refraction and axial angle are not consistent.

VOELCKERITE.

Ziller-Tal, Switzerland. Uniaxial −.

$\omega = 1.633 \pm 0.003$. $\epsilon = 1.629 \pm 0.003$.

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[33] Rosicky, V., Acad. Sci. Bohême Bull., vol. 17, No. 28, p. 19, 1908.

VOGLITE.

1. Joachimsthal, Bohemia. "Specimen from Vogl" (Yale). Green plates with a rhombic outline and an angle of about 75° between the edges. X is nearly normal to the plates and Z makes an angle of about 33° with the longer side in the acute angle. When turned on edge these plates show lamellar twinning with small extinction angles. The optical orientation of the plates is shown in figure 12. Optically +, $2E_{Na}=104° \pm$, $2V_{Na}=60° \pm$ (measured), $\rho < v$ (very strong). Pleochroic.

$\alpha=1.541 \pm 0.003$; deep bluish green. $\beta=1.547 \pm 0.003$; deep bluish green. $\gamma=1.564 \pm 0.003$; pale yellowish.

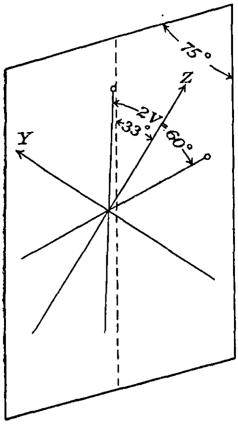

FIGURE 12.—Optical orientation of tabular crystals of voglite.

The mineral must be triclinic. It is no doubt voglite.

2. Joachimsthal (Cal. Min.). Green crystal coatings. Square tablets with a perfect basal cleavage. Uniaxial –, pleochroic.

$\omega=1.639 \pm 0.003$; pure pale green.
$\epsilon=1.631 \pm 0.003$; paler green to brownish.

Partly altered to a fibrous mineral with + elongation, strong birefringence, and about the same index of refraction as the fresh mineral.

This mineral is near zeunerite in its optical properties except that it has low birefringence.

3. Several other specimens labeled voglite proved to be uranothallite.

VOLBORTHITE.

1. Glenn County, Calif. (U. of C.). Green plates. Z is inclined to the normal to the plates. Optically +, 2V ranges from a large angle to 90°, $\rho > v$ (very strong). Some is probably optically –, 2V near 90° $\rho < v$ (very strong). Dispersion of the bisectrices is strong. Basal plates show very abnormal interference colors, and some show a grating, which is probably due to polysynthetic twinning. In section very pale green and nonpleochroic.

$\alpha=2.00 \pm 0.01$. $\beta=2.01 \pm 0.01$. $\gamma=2.02 \pm 0.01$.

2. Perm, Russia (U. S. N. M. 78385). Optically –, $2E=50° \pm 10°$, $2V=24° \pm 5°$ (measured), $\rho > v$ (very strong). 2V is 0 for violet, X is nearly normal to the plates. Faintly pleochroic.

$\alpha=2.01$; nearly colorless. β and $\gamma=2.02$; pale green.

From the preceding data it appears that the mean index of refraction and the birefringence of volborthite are fairly constant and that it is characterized by very strong dispersion, with $\rho > \upsilon$ about the bisectrix which emerges from the plates. This may be either the acute (+), obtuse (−), or acute (−).

VOLTAITE.

Sierra de Caporasee, Chile (Col. Roebling). Isotropic, fracture conchoidal, color in section oil green.

$$n = 1.602 \pm 0.003.$$

A mineral that has the following optical properties is associated with the voltaite in very fine grains: Uniaxial +.

$$\omega = 1.530 \pm 0.003. \qquad \epsilon = 1.537 \pm 0.003.$$

Shows very abnormal interference colors. These data are somewhat similar to those of coquimbite and it may be a related mineral.

VOLTZITE.

Elias mine, Joachimsthal (U. S. N. M. 84641), Bohemia. Compact, colorless, fibrous. Z is parallel to the elongation, uniaxial +.

$$n \text{ about } 2.03.$$

Birefringence rather strong. In liquids of high index made by dissolving sulphur and arsenic trisulphide in methylene iodide the mineral alters. In a liquid in which $n = 2.20$ it alters very slowly, even when hot, but in a liquid in which $n = 2.025$ it alters very quickly, the elongation remains +, the index of refraction increases, and the birefringence decreases. In a liquid in which $n = 1.91$ the grains rapidly become isotropic and liquid drops appear. After the alteration n is above 2.20. In the sulphur-selenium melts the alteration is much less rapid.

WALPURGITE.

1. Joachimsthal, Austria (U. S. N. M. 83971). Yellow plates. X is nearly normal to the plates. Optically −, 2V medium large.

$$\alpha = 1.90 \pm 0.03. \qquad \beta = 2.00 \pm 0.03. \qquad \gamma = 2.05 \pm 0.03.$$

2. Schneeberg, Saxony (Col. Roebling). Tabular crystals containing zonal growths which have variable optical properties. The outline is a parallelogram with an angle of about 66° between the

edges. The optical orientation of the plates is shown in figure 13. Optically –, 2V = 52° (indices), dispersion slight. X is nearly normal to the plates, which have an extinction angle ($Y' \wedge$ long edge in obtuse angle) of about 12°. Plates turned on the long edge show twinning parallel to the flat face and an extinction angle of about 8°. The main part has fairly constant indices of refraction.

$\alpha = 1.871 \pm 0.005$. $\beta = 1.975 \pm 0.005$. $\gamma = 2.005 \pm 0.005$.

A clear border shows:

$\beta = 2.01 \pm 0.01$. $\gamma = 2.03 \pm 0.01$.

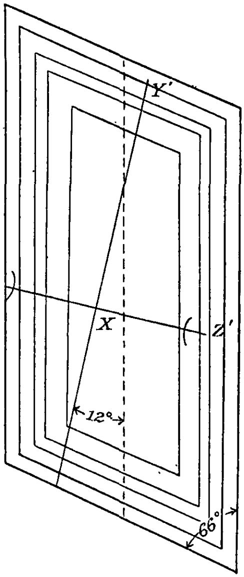

FIGURE 13.—Optical orientation of tabular {010} crystals of walpurgite.

WAPPLERITE.

Joachimsthal, Bohemia (A. M. N. H.). Fibers which tend to lie nearly normal to Z. The extinction is in part parallel, in part inclined. Optically +, 2V small.

$\alpha = 1.525 \pm 0.005$. $\beta = 1.53 \pm 0.01$.
$\gamma = 1.550 \pm 0.005$.

WARWICKITE.

Edenville, Orange County, N. Y. (U. S. N. M. 80720). Optically +, 2V small but variable, indices of refraction somewhat variable. Pleochroic in reddish brown with absorption $X > Y > Z$. Z normal to the cleavage.

$\alpha = 1.806 \pm 0.005$. $\beta = 1.809 \pm 0.005$.
$\gamma = 1.830 \pm 0.005$.

WATTEVILLITE.

Bauersburg, Bavaria (Col. Roebling). White bent hairlike crystals. Extinction of fibers is not uniform, X appears parallel to the elongation in some and normal in others. Some fibers normal to X show a large extinction angle. Optically –, 2E = 76° ± 5°, 2V = 48° ± 3° (measured), dispersion not perceptible.

$\alpha = 1.435 \pm 0.003$. $\beta = 1.455 \pm 0.003$. $\gamma = 1.459 \pm 0.003$.

WAVELLITE.

Bohemia (U. of C.). Optically +, 2V large, $\rho > v$ (perceptible).

$\alpha = 1.525 \pm 0.003$. $\beta = 1.534 \pm 0.003$. $\gamma = 1.552 \pm 0.003$.

WELLSITE.

Cullakanee mine, N. C. (U. S. N. M. 84472). Crystals with zonal growths and complex twinning. One section normal to the composition plane showed symmetrical extinction, and Z′ made a small angle to the trace of the composition plane. This angle varied in the different zones. Optically +, $2E=60°\pm$, $2V=39°\pm$, variable (measured).

$\alpha=1.498\pm0.003$. $\gamma=1.503\pm0.003$.

WIIKITE.

Finland (U. S. N. M. 9416). Isotropic, clouded. Index of refraction varies greatly. Average $n=2.0$, varies ±0.04.

WOLFRAMITE GROUP.

1. Nugget claim, Rollinsville, Gilpin County, Colo. (F. L. Hess). Ferberite. Black crystals. Nearly opaque, red in thin edges. No pleochroism noticed.

$\beta_{Li}=2.40\pm0.03$.

Birefringence very strong.

2. Cornwall, England (U. of C.). Wolframite. Optically +, 2V large. Absorption rather strong, $Z>X$.

$\alpha_{Li}=2.26\pm0.02$. $\beta_{Li}=2.32\pm0.02$. $\gamma_{Li}=2.42\pm0.02$.

3. Mariposa County, Calif. (U. of C.). Wolframite. In section darker colored and more nearly opaque than No. 1.

$\alpha_{Li}=2.31\pm0.03$. $\gamma_{Li}=2.46\pm0.03$.

4. South Homestake mine, White Oaks, N. Mex. Type analyzed for F. L. Hess.[34] Huebnerite. Contains only 0.55 per cent of FeO. Optically +, $2V=73°\pm5°$ (indices). In section brown and olive green, in part nearly opaque.

$\alpha=2.17\pm0.01$. $\beta=2.22\pm0.01$. $\gamma=2.32\pm0.01$.

5. Pony, Mont. (F. L. Hess). Huebnerite. Optically +, 2V large.

$\alpha=2.20\pm0.02$. $\gamma=2.30\pm0.02$.

YTTRIALITE.

Baringer Hill, Tex. (U. S. N. M. 85070). In section very pale green and isotropic. Fracture conchoidal.

$n=1.758\pm0.003$.

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[34] U. S. Geol. Survey Bull. 583, p. 24, analysis 4, 1914.

YTTROCERITE.

1. Edenville, Orange County, N. Y. (U. S. N. M. 47754). Dark violet-blue cubes. In section pale violet, with the color unevenly distributed. Isotropic.

$$n=1.434\pm0.003.$$

2. Sussex County, N. J. (A. M. N. H.). Dark violet-blue cubes. In section pale violet, with the color unevenly distributed. Isotropic.

$$n=1.435\pm0.003.$$

YTTROCRASITE.

Burnet County, Tex. (type from Prof. C. H. Warren). In part isotropic, in part weakly birefracting.

n ranges from 2.12 to 2.15.

YTTROTANTALITE.

Dillingo Moss, Sweden (Yale, B. Coll. 1854). In section red-brown and isotropic.

$$n=2.15\pm0.02.$$

ZARATITE.

Wood mine, Texas, Lancaster County, Pa. (U. S. N. M. 12633). Emerald-green opaline material. Isotropic. Banded. In the different bands n ranges from 1.56 to 1.61.

ZEPHAROVICHITE.

Trenic, Bohemia (Col. Roebling). Yellowish. Cryptocrystalline.

$$n=1.55\pm0.01.$$

Birefringence about 0.01 to 0.02. This mineral may be impure wavellite.

ZEUNERITE.

1. Schneeberg, Saxony (Col. Roebling). Green crystals, rudely cubic in habit. Uniaxial –. Pale green in section.

$$\omega=1.643\pm0.003. \qquad \epsilon=1.623\pm0.003.$$

2. See Uranospinite (p. 150).
3. See Voglite (p. 154).

ZINCALUMINITE.

Laurium, Greece (Col. Roebling). Basal plates and fibers. Uniaxial –.

$\omega = 1.534 \pm 0.003. \qquad \epsilon = 1.514 \pm 0.003.$

ZINCITE.

Franklin Furnace, N. J. (U. of C.). Red cleavage piece. Uniaxial +, in section deep red and not perceptibly pleochroic.

$\omega = 2.008 \pm 0.005. \qquad \epsilon = 2.029 \pm 0.005.$

ZINKOSITE.

Artificial. Made by dissolving metallic zinc in concentrated sulphuric acid and evaporating to dryness.

Tabular crystals {001} with rhombic outline and an angle of about 62° between the edges. X bisects the acute angle of the rhombs. Probably orthorhombic. $X = a, Y = b, Z = c$. The optical orientation is shown in figure 14.

Optically –, 2V medium to small, $\rho < v$ (strong).

$\alpha = 1.658 \pm 0.003. \qquad \beta = 1.669 \pm 0.003.$
$\gamma = 1.670 \pm 0.003.$

Alters on exposure to air. The same product results from the ignition of a hydrous zinc sulphate.

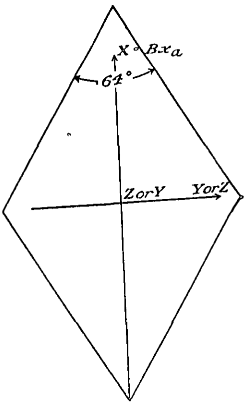

FIGURE 14.—Optical orientation of tabular crystals of zinkosite.

ZIPPEITE.

1. Joachimsthal, Bohemia (Col. Roebling). The specimen shows gypsum, crusts of an orange-yellow powder, rosettes of orange-yellow crystals, and greenish-yellow "woolly" fibers.

A. The orange-yellow powder is in plates with an acute rhombic outline. The acute bisectrix, X, emerges sensibly normal to these and Z approximately bisects the acute angle. On edge they show + elongation. Optically –, 2V rather large.

$\alpha = 1.630 \pm 0.010$; nearly colorless. $\beta = 1.70 \pm 0.01$; yellow, a little paler than γ. $\gamma = 1.720 \pm 0.005$; deep yellow.

B. The orange-yellow crystals are plates and laths. X is sensibly normal to the flat face. Laths show sharp extinction with $Z \wedge$ elongation 32° ± 3°; on edge they show parallel extinction. Optically –, 2V large, $\rho < v$ (?) slight.

$\alpha = 1.620 \pm 0.005$; nearly colorless. $\beta = 1.680 \pm 0.005$; pale yellow, near γ. $\gamma = 1.720 \pm 0.005$; deep yellow.

The crystals are probably monoclinic and tabular and probably have a perfect cleavage after {010}. $X=b$, $Z \wedge c=32° \pm 3°$.

C. The greenish-yellow fibers under the microscope are seen to be laths with sharp extinction, $Y \wedge$ elongation 15° ±. When turned on edge they show very abnormal interference colors and give no extinction in white light. These sections are nearly normal to an optic axis. Optically +, $2V_{Na}$ moderate, $\rho < v$ (extreme).

$$\beta=1.627 \pm 0.003.$$

Birefringence about 0.01.

This mineral is identical with uranopilite.

2. Telegraph mine, Gilpin County, Colo. (Col. Roebling). Labeled "Uraconite," but the mineral is a sulphate and near zippeite. Minute laths which are parallelograms in outline when lying on the flat face. Probably optically −, pleochroic. X is normal to the laths and extinction on the laths is Z to elongation 40° ± 2° in the obtuse angle of the parallelograms.

$\alpha=1.660 \pm 0.005$; nearly colorless. $\beta=1.710 \pm 0.005$; pale orange-yellow. $\gamma=1.760 \pm 0.005$; deep orange-yellow.

3. A sulphate of uranium near zippeite (W. T. Schaller). Apricot-yellow powder. Very minute laths ⊥ X, with the angle of Z to elongation 41°; on edge they give sensibly parallel extinction. Hence probably monoclinic, with {010} as the most prominent face and elongated along c and with $X=b$, $Z \wedge c=41$. Optically −, 2V large, dispersion not strong.

$\alpha=1.630 \pm 0.003$; nearly colorless. $\beta=1.689 \pm 0.003$; pale yellow-orange. $\gamma=1.739 \pm 0.003$; yellow-orange.

It seems probable that specimens 1A, 1B, 2, and 3 are the mineral zippeite and that the mineral varies somewhat, probably through isomorphic replacement of some constituent. Specimen 2 may be another mineral.

ZIRKELITE.

Jacupiranga, Brazil (Col. Roebling). In section clear reddish brown and isotropic.

$$n=2.19 \pm 0.01.$$

ZUNYITE.

Zuñi mine, Anvil Mountain, near Silverton, Colo. (type, U. S. N. M.). Clear, colorless crystals. Isotropic.

$$n=1.589 \pm 0.003.$$

CHAPTER V.—TABLES FOR THE DETERMINATION OF MINERALS FROM THEIR OPTICAL PROPERTIES.

ARRANGEMENT OF THE DATA IN THE TABLES.

In the tables the minerals are divided into six groups—isotropic, uniaxial positive, uniaxial negative, biaxial positive, biaxial negative, or optical character unknown. The last group includes only a few minerals, mostly very finely crystalline. As the indices of refraction are the most characteristic and the most easily measured of the optical constants, the minerals in each group are arranged in the order of the intermediate index of refraction, β.

The data for each mineral are arranged along a horizontal line. For biaxial minerals the three left-hand columns show the three indices of refraction in the order α, γ, β. The birefringence is not given, for it can be determined by subtracting α from γ. After the indices of refraction the name of the mineral is given, and beneath it the chemical composition in the dualistic form. Then follows the axial angle, 2V, and beneath it the dispersion of the optic axis. Next comes the optical orientation, and beneath it the dispersion of the principal optical directions (bisectrices). The crystal system is next given, and beneath it the crystal habit. The next column shows the cleavage, and the next the color of the mineral in the hand specimen. Then follows the hardness and specific gravity. In the last column, under remarks, is given the group to which the mineral belongs, the solubility, the fusibility, the pleochroism, twinning, and other properties. For isotropic and uniaxial minerals the arrangement is the same, but some of the columns are omitted. For a few minerals only one index of refraction is known, and the birefringence is then given.

The birefringence is said to be weak if it is less than 0.010, moderate if between 0.010 and 0.025, strong if between 0.025 and 0.100, very strong if between 0.100 and 0.200, and extreme if greater than 0.200. The axial angle is said to be small if it is estimated to be less than 30°, moderate if between 30° and 60°, and large if over 60°. The dispersion of the optic axis is said to be perceptible if a good interference figure shows faintly perceptible colored borders, weak if a little more easily seen, moderate if easily seen, strong if the hyperbolas are rather broad, colored bands, and extreme if the colored hyperbolas cover much of the field of the microscope.

The attempt has not been made to describe all the phenomena observed under the microscope but rather to give the chief optical constants and any exceptional properties that are not simply manifestations of these optical constants. For example, the section (010) of a monoclinic mineral with strong dispersion of the bisectrices will not give sharp extinction in white light but a succession of abnormal interference colors over an angle whose width depends upon the strength of dispersion. Minerals that have strong dispersion of the optic axis will give abnormal interference colors in white light on sections nearly normal to an optic axis. In general, abnormal interference colors are due to strong dispersion. The positions of the optical directions with relation to cleavage or other crystal direction are easily determined, except in triclinic minerals, if the position of the cleavage and of the principal optical directions in the crystal are known. For example, gypsum has a very perfect cleavage (010) and $Y = b$; hence cleavage pieces are parallel to the plane of the optic axes and will show the emergence of Y.

COMPLETENESS OF THE DATA.

In the classification and nomenclature of the minerals Dana's "System of Mineralogy" has been followed with few exceptions although that classification is now greatly in need of revision. With the exception of the opaque minerals and a few others that are noted in the index and elsewhere, all the species recognized in Dana's System, including the first three appendices, are included in the tables as well as a considerable number of minerals not considered species in the system and many subspecies of the better known groups. Some minerals whose optical properties differ in different specimens have been inserted in the tables several times. The indices of refraction of about 20 very rare minerals have been roughly estimated from the chemical composition and specific gravity, and these estimated indices have determined the position of the minerals in the tables.

It must be borne in mind that a large number of the minerals are variable in all their properties through isomorphism and solid solution. For most species this variability is within moderate limits, and if the properties of the end members are known those of the intermediate members can be estimated. As yet only a few mineral groups have been systematically studied and for many groups the only available constants are for one or more imperfectly placed intermediate members. Where the data were available the end members are placed in the tables and, in many groups one or more intermediate members. Ultimately it is hoped that all optical measurements will be closely tied to good chemical analyses. The data given in the tables as a rule are commonly for particular specimens, and other specimens, even from the same locality, may differ somewhat in indices of refraction and other properties. If the axial angle is large a comparatively small difference may change the optical character and such minerals should be looked for in both the optically positive and negative groups.

For more complete descriptions of the minerals the standard mineralogies should be consulted, particularly Dana's "System of Mineralogy" and Hintze's "Handbuch der Mineralogie."

TABLES.

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences.*

	β	Birefringence.
Air	1.000	0.000
Hieratite	(?)	0.000
Ice	1.309	0.004
Villiaumite	1.328	Very weak.
Water	1.333	0.000
Cryolithionite	1.339	0.000
Chiolite	1.349	0.007
Cryolite	1.364	Weak.
Cryptohalite	1.370	0.000
Sellaite	1.378	0.012
Mirabilite	1.396	0.004
Chrysocolla(?)	1.40 ±	Moderate.
Termierite	1.403±	0.000
Opal	1.406±	0.000
Pachnolite	1.413	0.008
Thomsenolite	1.414	0.008
Natron	1.425	0.035
Ralstonite	1.427	0.000 to weak.
Yttrocerite	1.434	0.000
Fluorite	1.434	0.000
Opal	1.440±	0.000
Erionite	1.44	0.014
Stercorite	1.441	0.030
Taylorite	1.448	0.012
Covellite	1.45	....
Brewsterite	1.45	0.012
Lecontite	1.452	0.013
Kalinite	1.452	0.028
Sulphohalite	1.454	0.000
Gearksutite	1.454	0.008
Wattevillite	1.455	0.024
Epsomite	1.455	0.028
Sassolite	1.456	0.119
Alum	1,456	0.000
Yttrofluorite	1.457	0.000
Mendozite	1.458	0.026
Tschermigite	1.459	0.000
Chrysocolla(?)	1.46 ±	0.11
Opal	1.46	0.000
Mallardite	....	....
Melanophlogite	1.461	0.000
Mendozite	1.461	0.014
Picromerite	1.463	0.015
Mendozite	1.463	0.012
Aluminite	1.464	0.011
Mordenite	1.465	0.005
Halloysite	1.470±	0.000
Hatchettite	1.47	0.03
Gmelinite	1.47	0.004
Tridymite	1.47	0.004
Allophane	1.47 ±	0.000
Neotocite	1.47 ±	0.000
Lansfordite	1.47	0.05
Paraluminite	1.470	0.009
Borax	1.470	0.025
Boussingaultite	1.470	0.010
Flokite	1.473	0.002
Gmelinite	1.474±	0.001 to 0.008
Thenardite	1.474	0.021
Laubanite	1.475	0.011
Carnallite	1.475	0.028
Alunogen	1.476	0.009
Creedite	1.478	0.024
Melanterite	1.478	0.015
Ferrierite	1.479	0.004
Faujasite	1.48	0.000±
Pisanite	1.479	0.015
Chabazite	1.480±	0.002
Boothite	(?)	0.01
Misenite	1.480	0.012
Dietrichite	1.480	0.013
Ptilolite	1.480	0.004
Phillipsite	1.48	0.003
Goslarite	1.480	0.027
Pickeringite	1.480	0.007
Vashegyite	1.48	0.02
Hanksite	1.481	0.02
Darapskite	1.481	0.095
Apjohnite	1.482	0.004
Kalicinite	1.482	Strong.
Natrolite	1.482	0.013
Zinc-copper melanterite	1.483	0.009
Sodalite	1.483	0.000
Bieberite	1.483	0.012
Evansite	1.485	0.000
Cristobalite	1.486	0.003
Leonite	1.487	0.007
Analcite	1.487	0.001
Tamarugite	1.487	0.012
Hackmanite	1.487	0.000
Bloedite	1.488	0.003
Vanthoffite	1.488	0.004
Douglasite	1.488	0.012
Morenosite	1.489	0.025
Vashegyite	1.49 ±	0.000
Allophane	1.49 ±	0.000
Sylvite	1.490	0.000
Hydronephelite	1.490	0.012
Ettringite	1.49	0.01
Loeweite	1.490	0.019
Fluellite	1.490	0.038
Halotrichite	1.49	0.005
Stellerite	1.49	0.011
Cyanochroite	1.491	Moderate.
Aphthitalite	1.491	0.008
Trona	1.492	0.128
Noselite	1.495	0.000
Arcanite	1.495	0.003
Struvite	1.496	0.009
Haüynite	1.496	0.000
Epidesmine	1.498	0.015
Nitrocalcite	1.498	0.039
Stilbite	1.498	0.006
Heulandite	1.499	0.007
Levynite	1.50	Strong.
Wellsite	1.50	0.005
Bilinite	1.500	Weak.
Nitroglauberite	1.500	0.125
Rosiérésite	1.5	0.000
Lazurite	1.50 ±	0.000

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.		β	Birefringence.
Stevensite	1.50 ±	0.000	Hydromagnesite	1.530	0.013
Didymolite	1.501	0.015	Milarite	1.532	0.003
Nesquehonite	1.501	0.114	Quetenite	1.532	0.056
Paraffin	1.502	0.048	Glauberite	1.532	0.021
Antigorite	1.502±	0.021	Echellite	1.533	0.015
Uranothallite	1.503	0.039	Fibroferrite	1.533	0.042
Prosopite	1.503	0.009	Zinc-copper chalcanthite	1.533	0.027
Thomsonite	1.503	0.028	Hydroboracite	1.534	0.048
Ulexite	1.504	0.029	Artinite	1.534	0.068
Harmotone	1.505	0.005	Zincaluminite	1.534	0.020
Mesolite	1.505	0.001	Wavellite	1.534	0.027
Niter	1.505	0.172	Succinite	1.535±	0.000
Kainite	1.505	0.022	Langbeinite	1.535	0.000
Nitromagnesite	1.506	0.17	Apophyllite	1.535	0.002
Thermonatrite	1.506	0.104	Bromcarnallite	1.535	Very strong.
Parasepiolite	1.506	0.011	Kieserite	1.535	0.063
Thaumasite	1.507	0.039	Meyerhofferite	1.535	0.060
Sulphatic cancrinite	1.507	0.007	Iron-copper chalcanthite	1.536	0.026
Bischofite	1.507	0.033	Teschemacherite	1.536	0.132
Tychite	1.508	0.000	Kaliophilite	1.537	0.004
Manganese chalcanthite	1.508	0.019	Siderotil	1.537	0.015
Ussingite	1.508	0.041	Apophyllite	1.537	0.002
Leucite	1.509	0.001	Chalcedony	1.537	0.01
Nocerite	1.509	0.023	Cordierite	1.538	0.006
Pirssonite	1.510	0.071	Mellite	1.539	0.028
Phillipsite	1.51	0.003	Marialite (pure)	1.539	0.002
Petalite	1.510	0.012	Gismondite	1.539	0.008
Uranospathite	1.510	0.03	Chalcanthite	1.539	0.030
Epistilbite	1.510	0.010	Brugnatellite	1.540	0.030
Inyoite	1.51	0.025	Deweylite	1.54	(?)
Hisingerite	1.51 ±	0.000	Cornuite	1.54 ±	0.000
Montmorillonite	1.51	Weak.	Chrysotile	1.54	0.013±
Hydrotalcite	1.512	0.014	Sulphoborite	1.540	0.017
Northupite	1.514	0.000	Luenebergite	1.54	0.025
Okenite	1.514	0.003	Leverrierite	1.541	0.043
Ozocerite	1.515	0.025	Halloysite	1.542±	0.000
Gonnardite	1.515	0.006	Nephelite	1.542	0.004
Leverrierite	1.516	0.046	Stichtite	1.542	0.026
Gaylussite	1.516	0.079	Dawsonite	1.542	0.130
Planerite	1.517	0.000	Oligoclase	1.543	0.008
Meerschaum	1.517	0.000	Halite	1.544	0.000
Syngenite	1.517	0.018	Quartz	1.544	0.009
Davyne	1.518	0.003	Pholidolite	1.545	0.042
Felsoebanyite	1.518	0.017	Eucryptite	1.545	Low.
Leifite	1.518	0.004	Gyrolite	1.545	0.01
Monetite	1.518	0.010	Sussexite	1.545	0.013
Newberyite	1.518	0.019	Brushite	1.545	0.012
Scolecite	1.519	0.007	Hyalophane	1.545	0.005
Halloysite	1.52 ±	0.000	Eudidymite	1.546	0.006
Hydrophilite	1.52	0.000	Voglite	1.547	0.023
Larderellite	1.52	0.051	Copiapite	1.547	0.060±
Bobierite	1.520	0.033	Oxammite	1.547	0.156
Hautefeuillite	1.52	0.03	Botryogen	1.548	0.028
Chlorocalcite	1.52	Weak.	Edingtonite	1.549	0.016
Searlesite	1.52	0.008	Cobalt chalcanthite	1.549	0.021
Sepiolite	1.52	0.010	Coquimbite	1.550	0.006
Zebedassite	1.52 ±	Strong.	Neotocite	1.55 ±	0.000
Carnegieite	1.52	0.004	Ascharite	1.55	0.02
Microsommite	1.521	0.008	Zepharovichite	1.55	0.02±
Natrodavyne	1.522	0.005	Mizzonite ($Ma_{75}Me_{25}$)	1.551	0.013
Tachhydrite	1.522	0.009	Narsarsukite	1.553	0.031
Gypsum	1.523	0.010	Andesine	1.553	0.007
Mascagnite	1.523	0.012	Grothine	1.554	0.016
Hatchettite	1.523	0.070	Halloysite	1.555	0.000
Cancrinite	1.524	0.028	Soumansite	1.555	(?)
Laumontite	1.524	0.012	Saponite	1.555	0.01
Orthoclase	1.524	0.008	Rhomboclase	1.555	0.102
Pollucite	1.525	0.000	Whewellite	1.555	0.159
Sideronatrite	1.525	0.078	Miloschite	1.555	0.007
Minasragrite	1.525	0.030	Okenite	1.556	0.009
Hintzeite	1.526	0.042	Rivaite	1.56	Weak.
Microcline	1.526	0.008	Ferrinatrite	1.558	0.053
Albite	1.529	0.011	Variscite	1.558	0.031
Copiapite	1.529±	0.066	Beryllonite	1.558	0.009
Anorthoclase	1.529	0.008	Brucite	1.559	0.021
Spadaite	1.53 ±	0.000	Anemousite	1.559	0.008
Kehoeite	1.53 ±	0.000	Newtonite	1.560	0.020
Tavistockite	1.530	0.022	Jefferisite	1.560	0.02
Ilesite			Colerainite	1.56	Weak.
Wapplerite	1.53	0.025	Humboldtine	1.561	0.198

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.
Faratsihite	1.56	Moderate.
Scacchite	....	0.000
Cordierite	1.562	0.011
Polyhalite	1.562	0.019
Labradorite	1.563	0.009
Kaolinite	1.565	0.006
Pinnoite	1.565	0.010
Zeophyllite	1.565	0.005
Pyroaurite	1.565±	0.01
Elpidite	1.565	0.014
Gibbsite	1.566	0.021
Wernerite (Ma$_{50}$Me$_{50}$)	1.567	0.022
Collophanite	1.568	0.000
Isoclasite	1.568	0.015
Epididymite	1.569	0.004
Griffithite	1.569	0.087
Morinite	....	....
Lacroixite	1.57	....
Zaratite	1.57 ±	0.000
Bauxite	1.57 ±	0.000
Lawrencite	1.57	Weak.
Phillipsite	1.57	0.010
Tengerite	1.57	0.030
Wagnerite	1.570	0.013
Bowlingite	1.57 ±	0.025
Antigorite	1.570	0.011
Nitrobarite	1.571	0.000
Hoernesite	1.571	0.033
Roemerite	1.571	0.059
Alunite	1.572	0.020
Hannayite	1.572	0.020
Bytownite	1.572	0.010
Bassetite	1.574	0.02
Biotite	1.574	0.033
Loewigite	1.575	0.01
Autunite	1.575	0.024
Calcioferrite	1.555	0.005
Penninite	1.576	0.003
Anhydrite	1.576	0.043
Augelite	1.576	0.014
Sphaerite	1.576	0.026
Kroehnkite	1.578	0.057
Penninite	1.579	0.002
Bavenite	1.579	0.005
Sheridanite	1.580	0.009
Cryophyllite	1.58	0.03
Ripidolite	1.580	0.009
Manandonite	(?)	0.014
Ježekite	1.58	0.03
Cookeite	1.58 ±	Rather strong.
Coeruleolactite	1.580	0.008
Beryl (low in alkalies)	1.581	0.006
Leverrierite	1.582	0.028
β Hopeite	1.582	0.008
Wernerite (Ma$_{25}$Me$_{75}$)	1.582	0.031
Chrome clinochlore	1.582	0.011
Cacoxenite	1.582	0.063
Uranospinite	1.582	0.027
Alumian	1.583	0.019
Eakleite	1.583	0.010
Peganite	1.583	0.025
Bakerite	1.583	0.02 ±
Anorthite	1.584	0.012
Schroetterite	1.584	0.000
Natroalunite	1.585	0.01
Nontronite	1.585	0.025
Kupferite	1.585	0.013
Lucinite	1.585	0.029
Volchonskite	1.585	mod.
Clinochlore	1.586	0.011
Lanthanite	1.587	0.09
Rumpfite	1.587	Low.
Soda niter	1.587	0.251
Pyrophyllite	1.588	0.048
Talc	1.589	0.050
Pharmacolite	1.589	0.011
Celsian	1.589	0.010
Rinneite	1.589	0.001
Zunyite	1.589	0.000
Zaratite	1.59 ±	0.000
Hisingerite	1.59 ±	0.000
Collophanite	1.59 ±	0.000
Chloromanganokalite	1.59	Very weak.
Connarite	1.59 ±	0.03
Garnierite	1.59	Low.
Custerite	1.59	0.012
α Hopeite	1.59	0.018
Nontronite	1.590	0.020
Muscovite	1.590	0.033
Diabantite	1.59	0.055
Metavoltaite	1.591	0.018
Hambergite	1.591	0.071
Priceite	1.591	0.022
Hiddenite	1.592	0.011
Catapleiite	1.592	0.036
Colemanite	1.592	0.028
Torbernite	1.592	0.010
Amblygonite	1.593	0.018
Alurgite	1.594	0.04
Astrolite	1.594	0.027
Fuchsite	1.594	0.04
Crandallite	1.595	0.010
Szmikite	1.595	0.070
Cuspidine	1.595	0.012
Leucophanite	1.595	0.027
Gilpinite	1.596	0.036
Meionite (pure)	1 597	0.037
Chrysocolla	1.597	0.023
Cordierite	1.597	0.007
Amesite	1.597	0.015
Lepidolite	1.598	0.045
Howlite	1.598	0.019
Beryl (high in alkalies)	1.598	0.008
Stibiconite	1.60 ±	0.000
Biotite	1.600	Strong.
Cebollite	1.60	0.033
Leverrierite	1.600	0.045
Chloraluminite	1.60	0.053
Spencerite	1.600	0.016
Zinnwaldite	1.60	0.03
Riversidite	1.600	0.008
Paragonite	1.60	0.03
Borickite	1.60 ±	0.000
Haidingerite	1.602	0.048
Fremontite	1.603	0.021
Crestmorite	1.603	0.014
Vivianite	1.603	0.054
Sarcolite	1.604	0.011
Voltaite	1.604	0.000
Prochlorite	1.605	Low.
Martinite	1.605	0.02
Bertrandite	1.605	0.023
Amarantite	1.605	0.100
Phlogopite	1.606	0.044
Pectolite	1.606	0.039
Eudialyte	1.606	0.005
Corundophilite	1.607	0.006
Dahllite	1.608	0.004
Nontronite	1.61	0.025
Hillebrandite	1.61	0.007
Zaratite	1.61 ±	0.000
Diadochite	1.61 ±	0.000
Collophanite	1.61 ±	0.000
Gummite	1.61 ±	0.000
Montebrasite	1.611	0.020
Meliphanite	1.612	0.019
Aphrosiderite	1.612	0.004
Herderite	1.612	0.029
Anapaite	1.613	0.047
Stokesite	1.613	0.010
Fluocerite	1.615	0.005
Calamine	1.617	0.022
Cyanotrichite	1.617	0.067
Chondrodite	1.619	0.030
Delessite	1.619	0.014
Turquoise	1.62	0.04
Nontronite	1.62	0.015
Pargasite	1.620	0.019
Topaz	1.620	0.008
Churchite	1.620	0.034
Bisbeeite	1.620	0.10

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.
Torbernite	1.62	0.002±
Gilespite	1.621	0.002
Eucolite	1.621	0.003
Uranopilite	1.623	0.010
Tremolite	1.623	0.026
Uranocircite	1.623	0.013
Celestite	1.624	0.009
Destinezite	1.625	0.050
Goyazite	1.625	0.010
Francolite	1.625	Low.
Parahopeite	1.625	0.023
Georceixite	1.625	Weak.
Nepouite	1.625	0.037±
Roscherite	1.625	Moderate.
Georceixite	1.625	Weak.
Bazzite	1.626	0.021
Prehnite	1.626	0.033
Actinolite	1.627	0.025
Troegerite	1.627	0.045
Glauconite	1.628	0.008
Wollastonite	1.629	0.015
Mariposite	1.63 ±	0.03
Homilite (altered)	1.63	0.02
Ectropite	1.63	0.01
Dravite	1.632	0.019
Bementite	1.632	0.030
Chalcophyllite	1.632	0.057
Picropharmacolite	1.632	0.009
Bityite	1.63	Strong.
Carpholite	1.63	0.022
Richterite	1.63	0.02
Chrysocolla (?)	1.63	0.05
Celadonite	1.63	0.013
Lazulite	1.632	0.036
Åkermanite	1.633	0.006
Voelckerite	1.633	0.004
Danburite	1.634	0.004
Melilite	1.634	0.005
Apatite	1.634	0.003
Podolite	1.635	0.007
Pitticite	1.635±	0.000
Dahllite	1.635	0.004
Gedrite	1.636	0.021
Grandidierite	1.636	0.037
Inesite	1.636	0.035
Schizolite	1.636	0.029
Barite	1.637	0.012
Cumingtonite	1.638	0.022
Lepidomelane	1.638	0.052
Glaucophane	1.638	0.017
Andalusite	1.638	0.011
Thuringite	1.64 ±	0.01
Jeremejevite	1.64	Moderate?
Roeblingite	1.64	0.02
Svanbergite	1.64	0.01
Griphite	1.64 ±	0.000
Lagonite	1.64 ±	0.000
Homilite (altered)	1.640±	0.000
Salmiac	1.642	0.000
Anthophyllite	1.642	0.024
Serpierite	1.642	0.063
Sillimanite (pure)	1.642	0.015
Hornblende	1.642	0.024
Margarite	1.643	0.013
Humite	1.643	0.035
Zeunerite	1.643	0.020
Plancheite	1.644	0.058
Dioptase	1.644	0.053
Fairfieldite	1.644	0.018
Nontronite	1.645	0.03
Elbaite	1.647	0.018
Hellendite	(?)	0.01
Daphnite	1.649	0.006
Herrengrundite	1.649	0.075
Mosandrite	1.649	0.012
Phosphophyllite	1.65	0.025
Koninckite	1.65 ±	0.011
Equeiite	1.65 ±	0.000
Auerlite	1.65	0.01
Bementite	1.650	0.026
Szaibelyite	1.65	0.06
Homilite (altered)	1.650	0.02
Barrandite	1.65 ±	0.03
Friedelite	1.65	0.03
Chloropal	1.65	0.03
Epistolite	1.650	0.072
Liroconite	1.652	0.063
Datolite	1.653	0.044
Enstatite (pure)	1.653	0.008
Messelite	1.653	0.040
Cabrerite	1.654	0.07
Hureaulite	1.654	0.013
Jadeite	1.654	0.029
Clinoenstatite	1.654	0.009
Dioptase	1.654	0.053
Phenacite	1.654	0.016
Plumbogummite	1.654	0.022
Rhabdophanite	1.654	0.049
Wilkeite	1.655	0.005
Eosphorite	1.655	0.029
Uranochalcite	1.655	0.007
Euclase	1.655	0.019
Palaite	1.656	0.008
Natrochalcite	1.656	0.065
Chondrodite	1.656	0.03
Reddingite	1.656	0.032
Seybertite	1.657	0.012
Annabergite	1.658	0.065
Veszelyite	1.658	0.055
Calcite (pure)	1.658	0.172
Sillimanite	1.660	0.021
Brandisite	1.660	0.012
Tilasite	1.660	0.035
Xanthophyllite	1.660	0.012
Stewartite	1.66	0.06
Salmonsite	1.66	0.015
Sillimanite	1.660	0.021
Triplite	1.660	0.022
Fermorite	1.660	Weak.
Leucosphenite	1.661	0.043
Erythrite	1.661	0.073
Forsterite	1.661	0.040
Monticellite	1.662	0.017
Dickinsonite	1.662	0.013
Lindackerite	1.662	0.098
Friedelite	1.664	0.035
Homilite	1.665	0.02 ±
Triplite	1.665±	0.02
Spodumene	1.666	0.016
Johnstrupite	1.666	0.012
Gehlenite	1.666	0.005
Boracite	1.667	0.011
Strontianite	1.667	0.147
Uranophane	1.667	0.027
Symplesite	1.668	0.068
Rinkite	1.668	0.016
Zinkosite	1.669	0.012
Enstatite	1.669	0.009
Velardenite	1.669	0.011
Schorlite	1.669	0.031
Hardystonite	1.669	0.012
Borickite	1.67 ±	0.000
Prolectite	1.670	0.04
Lotrite	1.67	0.014
Hibschite	1.67	0.000
Clinohumite	1.670	0.032
Clinohedrite	1.670	0.01
Crossite	1.670	Weak.
Viridine	1.671	0.029
Strigovite	1.67	0.02
Bromlite	1.671	0.146
Hinsdalite	1.671	0.019
Diopside	1.671	0.030
Fillowite	1.672	0.004
Durangite	1.673	0.048
Hornblende	1.673	0.022
Spurrite	1.674	0.039
Natrophilite	1.674	0.013
Spodiosite	1.674	0.036
Lawsonite	1.674	0.019
Liskeardite	1.675	0.028
Ludlamite	1.675	0.044
Pyrosmalite	1.675	0.039
Chloromagnesite	1.675	0.085
Pharmacosiderite	1.676	0.000±
Parisite	1.676±	0.081

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.
Witherite	1.676	0.148
Kornerupine	1.676	0.012
Childrenite	1.678	0.041
Titan-olivine	1.678	0.033
Lithiophilite	1.679	0.011
Allanite	1.68 ±	0.000
Florencite	1.680±	0.005
Harstigite	1.68	0.005
Diopside	1.680	0.029
Olivine	1.680	0.037
Erythrosiderite	....	Strong.
Annabergite	1.68	0.05
Cenosite	1.681	0.016
Dolomite (pure)	1.68	0.18
Aragonite	1.682	0.155
Koettigite	1.683	0.055
Barytocalcite	1.684	0.161
Axinite	1.685	0.010
Schroeckingerite	1.685	0.032
Roscoelite	1.685.	0.094
Bronzite	1.685	0.012
Barylite	1.685	0.014
Uranopilite	1.68	0.03
Schorlite	1.685	0.033
Trichalcite	1.686	0.028
Dumortierite	1.686	0.011
Tourmaline	1.687	0.046
Aegirite-augite	1.687	0.029
Riebeckite	1.687	0.005
Rosenbuschite	1.687	0.029
Urbanite	1.688	0.031
Triphylite	1.688	0.004
Zippeite	1.689	0.109
Thorite (altered)	1.69	0.000
Jeffersonite	1.690	0.028
Stilpnomelane	1.69 ±	0.09
Hastingsite	1.69	Weak.
Rhodizite	1.69	0.00 ±
Gehlenite	1.691	0.000±
Pigeonite	1.691	0.021
Pharmacosiderite	1.693	0.005
Willemite	1.694	0.029
Kaersutite	1.694	0.032
Spangolite	1.694	0.053
Riebeckite	1.695	Low?
Basaltic hornblende	1.695	0.031
Hiortdahlite	1.695	0.012
Gruenerite	1.697	0.045
Euchroite	1.698	0.038
Ankerite ($CaCO_3$, 52.6 per cent; $MgCO_3$, 36.7; $FeCO_3$, 10.7)	1.698	0.185
Neptunite	1.699	0.046
Stibiconite	1.70 ±	0.000
Polycrase	1.70	0.000
Kremersite	....	....
Magnesite (pure)	1.700	0.191
Crocidolite	1.70	0.025
Gadolinite	1.70	0.05
Johannite (?)	1.70	Moderate.
Hainite	1.70	Low.
Plancheite	1.70	0.04
Arfvedsonite	1.70	0.021
Triphylite	1.702	Mod.
Hypersthene	1.702	0.013
Zoisite	1.702	0.006
Serendibite	1.703	0.005
Astrophyllite	1.703	0.055
Augite	1.704	0.025
Pyrope (pure)	1.705	0.000
Tarbuttite	1.705	0.053
Graftonite	1.705	0.024
Svabite	1.706	0.008
Barkevikite	1.707	0.021
Vesuvianite	1.708	0.003
Sapphirine	1.709	0.006
Strengite	1.71	0.035
Plazolite	1.710	0.000
Zippeite (?)	1.710	0.100
Merwinite	1.711	0.010
Gerhardtite	1.713	0.019
Strengite (manganiferous)	1.714	0.025
Brandtite	1.715	0.013
Woehlerite	1.716	0.026
Ankerite	1.716	0.190
Vesuvianite	1.716	0.005
Bastnaesite	1.717	1.101
Clinozoisite	1.719	0.007
Allanite	1.72 ±	0.000
Trimerite	1.720	0.010
Cyanite	1.720	0.016
Phosphuranylite	1.720	0.029
Adelite	1.721	0.019
Xenotime	1.721	0.095
Glaucochroite	1.722	0.049
Diaspore	1.722	0.048
Spinel (pure)	1.723	0.000
Pyrochroite	1.723	0.042
Connellite	1.724	0.022
Basaltic hornblende	1.725	0.072
Sarcopside	1.725	Weak.
Homilite	1.725	0.023
Rowlandite	1.725	0.000
Babingtonite	1.726	0.033
Triploidite	1.726	0.005
Magnesite ($FeCO_3$, 15 per cent)	1.726	0.199
Tyrolite	1.726	0.036
Berzeliite	1.727	0.000
Picrotephroite (Mg_2SiO_4, 40.4 per cent; Mn_2SiO_4, 59.6)	1.727	0.029
Ganophyllite	1.729	0.025
Clinozoisite	1.729	0.010
Mixite	1.730	0.080
Melanocerite	1.73 ±	0.01
Piedmontite	1.73	0.02
Ottrelite	1.73	0.01
Augite (TiO_2, 4.84 per cent)	1.73	0.021
Rhodonite	1.73	0.011
Gruenerite	1.73	0.056
Kaersutite	1.730	0.068
Stibiconite (?)	1.73	0.01 ±
Jeffersonite	1.731	0.028
Chalcomenite	1.731	0.022
Strengite	1.732	0.032
Molybdite	1.733±	0.215
Adamite	1.733	0.050
Hematolite	1.733	0.019
Gageite	1.734	0.013
Hodgkinsonite	1.735	0.035
Sicklerite	1.735	0.030
Roselite	1.735	0.01
Periclase	1.736	0.000
Grossularite (pure)	1.736	0.000
Hydrozincite	1.736	0.110
Hedenbergite	1.737	0.019
Antlerite	1.737	0.055
Danalite	1.737	0.000
Thalenite	1.738	0.013
Allanite	1.739	0.024
Helvite	1.739	0.000
Pilbarite	1.74 ±	0.000
Caryocerite (altered)	1.74 ±	0.000
Molengraaffite	1.74	0.035
Vilateite	1.74	Rather strong.
Tarapacaite	1.74 ±	(?)
Aurichalcite	1.74	0.089
Iddingsite	1.74	0.05
Staurolite	1.741	0.010
Pyrope	1.742	0.000
Scorodite	1.742	0.027
Pyreneite	1.745	0.003
Mixite	1.745	0.085
Libethenite	1.745	0.087
Chrysoberyl	1.748	0.010
Ankerite	1.749	0.202
Lavenite	1.750	0.03
Rutherfordine	1.75	0.08
Molybdite	1.75 ±	0.21

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.
Pyroxmangite	1.75	Low.
Chloritoid	1.75 ±	0.01 ±
Lorenzenite	1.75	0.045
Spinel	1.75 ±	0.000
Daviesite	1.752	0.016
Epidote	1.754	0.039
Caracolite	1.754	0.021
Arsenolite	1.754	0.000
Vegasite	1.755	0.065
Tritomite (altered)	1.757±	0.000
Benitoite	1.757	0.047
Azurite	1.758	0.108
Yttrialite	1.758	0.000
Stilpnomelane	1.76	0.13
Cordylite	1.760	0.183
Rhodolite	1.760	0.000
Langite	1.760	0.090
Cappelenite	(?)	Rather strong.
Dihydrite	1.762	0.086
Hessonite	1.763	0.000
Corundum	1.768	0.008
Nordenskioeldine	(?)	Strong.
Pleonaste	1.77 ±	0.000
Aegirite (vanadiferous)	1.770	0.037
Leucophoenicite	1.771	0.031
Piedmontite	1.771	0.061
Mackintoshite	1.77	0.000
Melanocerite (altered)	1.77 ±	0.000
Margarosanite	1.773	0.078
Scorodite	1.774	0.032
Barthite	1.774	0.013
Palmierite	(?)	Strong.
Taramellite	1.774	0.06
Orientite	1.776	0.037
Almandite	1.778±	0.000
Conichalcite	1.778	0.023
Brochantite	1.778	0.073
Allactite	1.779	0.019
Thortveitite	1.78	0.046
Stilpnomelane	1.78	0.13
Caryinite	1.780	0.029
Gadolinite	1.78 ±	0.005
Shattuckite	1.782	0.063
Roepperite	1.786	0.046
Beraunite	1.786	0.040
Mesitite	1.788	0.218
Olivenite	1.788	0.082
Lossenite	1.788	0.027
Retzian	1.788	0.023
Monazite	1.788	0.051
Uraconite	1.79	0.10
Molybdite	1.79 ±	0.26 ±
Ardennite	1.79	0.020
Hortonolite	1.792	0.035
Tephroite	1.792	0.034
Sarkinite	1.793	0.022
Scorodite	1.793	0.028
Arseniopleite	1.794	0.009
Barthite	1.795	0.035
Aegirite	1.799	0.050
Cronstedtite	1.80	Strong.
Thorite	(?)	(?)
Spessartite (pure)	1.800	0.000
Flinkite	1.801	0.050
Enigmatite	1.80	0.006
Ardennite	1.8	0.015
Ferritungstite	1.80	0.08
Remingtonite	1.80	0.25
Glockerite	1.80	0.05
Gahnite	1.80 ±	0.000
Stibiconite	1.80 ±	0.000
Hercynite	1.80 ±	0.000
Almandite	1.801	0.000
Olivenite	1.810	0.091
Warwickite	1.810	0.022
Hancockite	1.81	0.042
Spessartite	1.811	0.000
Beckelite	1.812	0.000
Molybdophyllite	1.815	0.054
Pascoite	1.815	0.050
Jarosite	1.817	0.105
Rhodochrosite (pure)	1.817	0.22
Leucochalcite	1.817	0.032
Naegite	1.818	0.000
Cerite	1.818	0.400
Smithsonite	1.818	0.200
Cornwallite	1.82	0.04
Carphosiderite	1.82	0.09
Carminite	(?)	Strong.
Erinite	1.825	0.06
Rhodochrosite	1.826	0.221
Malacon	1.826	0.000
Romeite	1.83	0.000±
Almandite	1.830	0.000
Lime	1.83	0.000
Siderite ($MgCO_3$, 24 per cent)	1.830	0.234
Higgensite	1.831	0.046
Knebelite	1.831	0.047
Natrojarosite	1.832	0.082
Chalcosiderite	1.834	0.072
Uvarovite	1.838	0.000
Linarite	1.838	0.050
Tagilite	1.84	0.16
Scorodite	1.84	Strong.
Dufrenite	1.840	0.055
Lautarite	1.840	0.096
Dietzeite	1.842	0.032
Siderite ($MnCO_3$, 16 per cent)	1.849	0.234
Armangite	(?)	Weak.
Ludwigite	1.85	0.17
Magnesioludwigite	1.85	0.15
Beaverite	1.85	0.04
Toernebohmite	1.852	0.033
Hoegbomite	1.853	0.050
Siderite	1.855	0.242
Sphaerocobaltite	1.855	0.25
Andradite	1.857	0.000
Purpurite	1.86	0.07
Bindheimite	1.86 ±	0.000
Atacamite	1.861	0.049
Fayalite	1.864	0.050
Ancylite	1.865±	0.04 ±
Caledonite	1.866	0.091
Romeite	1.87 ±	0.000±
Chalcolamprite	1.87 ±	0.000
Arseniosiderite	1.870	0.078
Synadelphite	1.87	0.04
Clinoclasite	1.870	0.18
Tyuyamunite	1.870±	0.225
Siderite (pure)	1.875	0.242
Plumbojarosite	1.875	0.089
Malachite	1.875	0.254
Uvanite	1.879	0.240
Hemafibrite	1.88	0.06
Tscheffkinite	1.88 ±	0.01
Arseniosiderite	1.88	0.08
Chenevixite	1.88	Rather strong.
Anglesite	1.882	0.017
Catoptrite	(?)	0.000
Heterosite	1.89	0.05
Andradite (pure)	1.895	0.000
Carnotite	1.895	0.20
Arseniosiderite	1.898	0.083
Trippkeite	1.90	0.22
Stibiconite	1.9 ±	0.000
Ardennite	1.9 ±	0.015
Titanite	1.907	0.134
Daubreeite	1.91	0.01 ±
Ilvaite	1.91	Strong.
Ganomalite	1.91	0.035
Nasonite	1.913	0.010
Hugelite	1.915	0.01
Scheelite	1.918	0.016
Claudetite	1.92	0.14
Tsumebite	1.920	0.071
Purpurite	1.92 ±	0.04 ±
Betafite	1.92 ±	0.000
Zircon	1.923±	0.045
Microlite	1.925	0.000
Carnotite	1.925	0.200
Corkite	1.93	Weak.
Tyuyamunite	1.93 ±	0.20

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.		β	Birefringence.
Nantokite	1.93	0.000	Cuprotungstite	2.15	Strong.
Keilhauite	1.935	0.115	Goethite (impure)	2.15 ±	0.07
Samirésite	1.94	0.000	Atelestite	2.15	0.04
Melanite	1.94 ±	0.000	Bismutite	2.16 ±	0.05 ±
Nasonite	1.945	0.026	Chromite	2.16 ±	0.000
Manganostibiite	1.95	0.04	Bellite	2.16	0.02
Durdenite	1.955	0.263	Manganosite	2.16	0.000
Beudantite	1.96	Weak.	Melanotekite	2.17	0.19
Zircon	1.960	0.055	Rhagite	(?)	(?)
Dixenite	1.96		Fergusonite	2.175±	0.000
Neotantalite	1.96 ±	0.000	Kleinite (biaxial)	2.18	0.02
Pyrochlore	1.96	0.000	Bunsenite	2.18_{red}	0.000
Alamosite	1.961	0.021	Uhligite	(?)	0.000
Hyalotekite	1.963	0.003	Hewettite	2.18	0.58
Tscheffkinite	1.965	0.000	Tellurite	2.18_{Li}	0.35
Powellite	1.967	0.011	Iodyrite	2.182	0.01
Tscheffkinite (altered?)	1.97	0.02	Zirkelite	2.19	0.000
Bayldonite	1.97	0.04	Kleinite (hexagonal)	2.19	0.02
Calomel	1.973	0.683	Baddeleyite	2.19	0.07
Walpurgite	1.975	0.134	Fergusonite	2.195±	0.000
Hatchettolite	1.98	0.000	Euxenite	2.195±	0.000
Schorlomite	1.98	0.000	Miersite	2.20	0.000
Uranosphaerite	1.985	0.10	Oldhamite		0.000
Lanarkite	1.99	0.09	Lewisite	2.20	0.000
Agricolite	1.99	Very low.	Bismutite	2.20 ±	0.000
Stibiconite	1.99 ±	0.000	Thorianite	2.20 ±	0.000
Cassiterite	1.997	0.096	Iodobromite	2.20	0.000
Bindheimite (?)	2.0	Strong.	Kentrolite	2.20	0.21
Wiikite	2.00	0.000	Tripuhyite	2.20	0.14
Ardennite	2.0 ±	0.015	Lepidocrocite	2.200	0.57
Pyrochlore	2.00	0.000	Phoenicochroite	(?)	(?)
Leadhillite	2.00	0.14	Eschynite	2.205	0.000
Hydrocyanite			Samarskite	2.21 ±	0.000
Dolerophanite			Iodyrite	2.21	0.01
Walpurgite	2.00	0.15	Polymignite	2.215	0.000
Zincite	2.008	0.021	Cotunnite	2.217	0.060
Ivaarite	2.01 ±	0.000	Huebnerite	2.22	0.15
Volborthite	2.01	0.02	Vauquelinite	2.22	0.11
Bismite	2.01	0.19	Goethite	2.22	0.08
Cumengeite	2.026	0.061	Euxenite	2.24 ±	0.000
Voltzite	2.03	Rather strong.	Manganite	2.24_{Li}	0.29
			Tungstite	2.24	0.17
Pseudoboléite	2.03	0.03	Endlichite	2.25	0.05
Sulphur	2.043	0.290	Samarskite	2.25 ±	0.000
Percylite	2.05	0.000	Bromyrite	2.253	0.000
Picotite	2.05 ±	0.000	Manganotantalite	2.25	0.07
Risorite	2.05 ±	0.000	Tantalite	2.25	0.15
Boléite	2.05	0.02	Descloizite	2.26	0.17
Fernandinite	2.05	Strong.	Cuprodescloizite	2.26	0.15
Eulytite	2.05	Very low.	Hetaerolite	2.26	0.16
Pyromorphite	2.050	0.008	Eschynite	2.26 ±	0.00
Calciovolborthite	2.05	0.09	Bismutite	2.26 ±	0.05
Pinakiolite	2.05	0.157	Stolzite	2.269	0.087
Sipylite	2.06 ±	0.000	Tapiolite	2.27_{Li}	0.15
Limonite	2.06 ±	0.000	Raspite	2.27	0.03
Euxenite	2.06 ±	0.000	Mendipite	2.27	0.07
Cerargyrite	2.061	0.000	Descloizite	2.27	0.17
Mosesite	2.065	0.000	Pyrobelonite	(?)	(?)
Chromite	2.07	0.000	Goethite	2.29	0.14
Barysilite	2.07	0.02	Manganotantalite	2.29	0.08
Cerusite	2.076	0.274	Monimolite	(?)	0.000
Senarmontite	2.087	0.000±	Knopite	2.30	0.000
Schneebergite	2.09	0.000±	Brannerite	2.30	0.000
Hydrocerusite	2.09	0.15	Hielmite	2.30_{Li}	0.10
Emmonsite	2.09 ±	0.15	Plattnerite	2.3_{Li}±	(?)
Montanite	2.09 ±	0.01	Cuprodescloizite	2.31_{Li}	0.12
Georgiadesite	(?)	(?)	Geikielite	2.31	0.36
Trigonite	2.1	0.08	Tantalite	2.32	0.17
Metahewettite	2.10	0.53	Ecdemite	2.32_{Li}	0.07
Fiedlerite	2.102	0.310	Wolframite	2.32_{Li}	0.16
Phosgenite	2.114	0.026	Ochrolite	(?)	(?)
Fergusonite	2.115±	0.000	Dysanalite	2.33	Weak.
Laurionite	2.116	0.081	Hetaerolite	2.34 ±	0.20
Ampangabéite	2.12	0.000	Marshite	2.346	0.000
Yttrocrasite	2.13 ±	0.000	Goethite	2.35_{Li}	0.14
Penfieldite	2.13	0.08	Schwartzembergite	2.35	0.11
Bismutosphaerite	2.13	0.19	Valentinite	2.35	0.17
Mimetite	2.135	0.017	Magnesioferrite	2.35_{Li}	0.000
Blomstrandine	2.142	0.000	Nadorite	2.35_{Li}	0.10
Yttrotantalite	2.15	0.000	Lorettoite	2.35_{Li}	0.02
Koppite	2.15 ±	0.000	Vanadinite	2.354	0.055
Embolite	2.15 ±	0.000	Wurtzite	2.33_{Li}	0.02
Matlockite	2.15	0.11		2.356_{Na}	0.022

TABLE 6.—*List of minerals arranged according to their intermediate indices of refraction, β, and showing their birefringences*—Continued.

	β	Birefringence.		β	Birefringence.
Franklinite	2.36_{Li} ±	0.000	Massicot	2.61_{Li}	0.20
Schwartzembergite	2.36_{Li}	0.11	Rutile	2.616	0.287
Långbanite	2.36_{Li}	0.05	Arizonite	2.62_{Li}	Moderate.
Wolframite	2.36_{Li}	0.15	Tenorite	2.63_{red}	Strong.
Brackebuschite	2.36_{Li}	0.20	Moissanite	2.633_{Li}	0.040
Sphalerite (pure)	2.34_{Li}	0.00		2.654_{Na}	0.043
	2.37_{Na}	0.00	Terlinguaite	2.64_{Li}	0.32
Crocoite	2.37_{Li}	0.35	Litharge	2.665_{Li}	0.130
Perofskite	2.38	Weak.	Hauerite	2.69_{Li}	0.000
Pseudobrookite	2.39_{Li}	0.04	Alabandite	2.70_{Li}	0.000
Ferberite	2.40_{Li}	Strong.	Cinnabar	2.819_{Li}	0.327
Ferrocolumbite	2.40_{Li}	Extreme.		2.857_{Na}	0.347
Wulfenite	2.402_{Li}	0.098	Cuprite	2.849	0.000
Stibiotantalite	2.404	0.083	Proustite	2.979_{Li}	0.268
Stibiocolumbite	2.419	0.061	Xanthoconite	3.	Extreme.
Diamond	2.419	0.000	Livingstonite	3.	Extreme.
Minium	2.42_{Li}	Weak.	Polybasite	3.	Very strong.
Greenockite	2.431_{Li}	0.025	Hematite	3.01_{Li}	0.3
	2.506_{Na}	0.023	Pyrargyrite	3.084	0.203
Columbite	2.45_{Li}	Strong.	Hutchinsonite	3.176_{Na}	0.110
Derbylite	2.45_{Li}	0.06	Hematite	3.22_{Li}	0.28
Hausmannite	2.46_{Li}	0.31	Smithite	3.27?	Very strong.
Sphalerite (FeS, 28 per cent)	2.47_{Na}	0.000	Stibnite	4.303	1.109
Pyrophanite	2.481	0.271	Tetrahedrite	$>2.72_{Li}$	0.000
Eglestonite	2.49_{Li}	0.000	Tennantite	$>2.72_{Li}$	0.000
Strueverite	2.50_{Li}	Moderate.	Chalcophanite	$>2.72_{Li}$	Extreme.
Senaite	2.50_{Li}	Low.	Orpiment	$>2.72_{Li}$	Extreme.
Montroydite	2.5_{Li}	0.28	Kermesite	$>2.72_{Li}$	Extreme.
Pucherite	2.50_{Li}	0.10	Miargyrite	$>2.72_{Li}$	Very strong.
Turgite	2.55_{Li}	0.10	Lorandite	$>2.72_{Li}$	Extreme.
Koechlinite	2.55_{Li}	Very strong.	Dufrenoysite	$>2.72_{Li}$	Very strong.
Anatase	2.554	0.061	Ilmenite	$>2.72_{Li}$	Very strong.
Smithite	2.58_{Li}	0.12	Sartorite	Very high.	(?)
Brookite	2.586	0.158	Pyrostilpnite	Very high.	(?)
Realgar	2.59_{Li}	0.15	Frieseite	Very high.	(?)
Trechmannite	2.6_{Li}	Extreme.	Vrbaite	Very high.	(?)

Abbreviations used in Table 7.

abs	absorption.
acic	acicular.
amor	amorphous.
anom	anomalous.
B	birefringence.
b. b	before the blowpipe.
biax	biaxial.
cleav	cleavage.
conct	concentrated.
conch	conchoidal.
decpd	decomposed.
dif	difficult.
disp	dispersion.
dist	distinct.
dodec	dodecahedral.
elong	elongation.
ext	extinction.
extr	extreme.
F	fusibility.
fib	fibers; fibrous.
fus	fusible.
G	specific gravity.
gelat	gelatinous; gelatinize.
H	hardness.
hex	hexagonal.
imperf	imperfect.
incl	inclined.
indist	indistinct.
infus	infusible.
insol	insoluble.
isomet	isometric.
isomor	isomorphous.
isot	isotropic.
mic	micaceous.
mkd	marked.
mod	moderate.
mon	monoclinic.
oct	octahedral.
opt	optical.
orient	orientation.
orth	orthorhombic.
penet	penetration.
perf	perfect.
perc	perceptible.
pl	plane.
pleoc	pleochroism; pleochroic.
poly	polysynthetic.
pris	prismatic.
ps	pseudo.
pyram	pyramidal.
rect	rectangular.
rhomboh	rhombohedral.
sol	soluble.
sq	square.
tab	tabular.
tetrag	tetragonal.
tetrah	tetrahedrons.
tr	trace.
tric	triclinic.
trig	trigonal.
tw	twinning.
uniax	uniaxial.

TABLE 7.—*Data for the determination of the nonopaque minerals.*

Isotropic group.

[Most of the minerals of this group are isometric: a considerable number are amorphous and therefore rather variable and indefinite in their chemical composition and all their properties; a few, which are included also in the proper birefracting group, are birefracting, but their birefringence is so weak or uncertain as to make them easily mistaken for isotropic minerals.]

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
Very low	Hieratite $2KF.SiF_4$	Isomet. Cubo-oct.		Gray	G=2.75	Sol. in hot H_2O.
1.328	Villiaumite NaF	Tetrag. Ps. isomet. Massive.	{001} perf. {100} {010}dist.	Carmine red	H=3.5 G=2.79	Sol. in H_2O. Very weak B. Uniax. —. ω=carmine red, ϵ=golden yellow.
1.333	Water H_2O	Fluid		Colorless	G=1.00	
1.339	Cryolithionite $3NaF.3LiF.2AlF_3$	Isomet	{110} dist	do	H=2.5 to 3 G=2.78	Sol. in acids. F=easy.
1.370	Cryptohalite $2NH_4F.SiF_4$(?)	Isomet. Cubo-oct.	{111} very perf		G=2.0	
1.403	Termierite $Al_2O_3.6SiO_2.18 \pm H_2O$(?)	Claylike	None	White, etc	H=2 G=1.21(?)	Slowly sol. in HCl. F=dif. Anom. B due to tension.
1.406±	Opal $SiO_2.nH_2O$	Amor	Conch	Varies	H=6± G=1.9 to 2.3	Insol. in acid; sol. in KOH.
1.427	Ralstonite $(Na_2,Mg)F_2.3Al(F,OH)_3.2H_2O$	Oct	None	Colorless, white, yellowish.	H=4.5 G=2.61	Decpd. by H_2SO_4. Infus. Opt. anom. Divides into birefracting octahedral segments.
1.434	Yttrocerite $(Y,Er,Ce)F_3.5CaF_2.H_2O$	Cubes	{111} perf	Violet, blue, etc	H=4 to 5 G=3.36 to 3.63	Sol. in acid. Infus.
1.434	Fluorite CaF_2	do	do	Colorless, purple, etc.	H=4 G=3.18	Sol. in acids. F=1.5.
1.440±	Opal $SiO_2.nH_2O$	Amor	Conch	Varies	H=6± G=2.1±	Sol. in KOH; insol. in acid. Infus.
1.454	Sulphohalite $2Na_2O.2SO_3.NaCl.NaF$	Dodec	None	Colorless	H=3.5 G=2.49	Slowly sol. in H_2O. F=1.
1.456	Alum $K_2O.Al_2O_3.4SO_3.24H_2O$	Oct	do	do	H=2 G=1.76	Potash alum. Sol. in H_2O. F=1.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.457±	Yttrofluorite $(Ca_3, Y_2)F_6$	Isomet	{111} imperf.	Yellowish	H=4.5 G=3.55	Sol. in acid. Fus.
1.459	Tschermigite $(NH_4)_2O.Al_2O_3.4SO_3.24H_2O$	Oct	None	White	H=2 G=1.64	Alum group. Sol. in H_2O. F=1. Opt. anom.
1.46	Opal $SiO_2.nH_2O$	Amor	Conch	Varies	H=6± G=2.2±	Sol. in KOH; insol. in acid. Infus.
1.461	Melanophlogite Contains SiO_2, SO_3, and H_2O	Cubes		Colorless	H=6.5 to 7 G=2.04	Insol. in acid. Infus.
1.47±	Neotocite $MnO.SiO_2.nH_2O$	Amor	Conch	Brown to black	H=4 G=2.6	Decpd. by acid. F=dif.
1.470±	Halloysite $Al_2O_3.2SiO_2.nH_2O$	Amor. Earthy, opaline.	do.	White, etc.	H=2 G=2.0 to 2.2	Insol. in acid. Infus. Data given are for mineral with 25 per cent H_2O. On long exposure to dry air or on heating to 60° C. for a few hours *n* increases to 1.555.
1.47±	Allophane $Al_2O_3.SiO_2.nH_2O$	Amor	Hyaline-like	Blue-green, etc.	H=3 G=1.8±	Gelat. Infus.
1.48	Faujasite $Na_2O.CaO.2Al_2O_3.10SiO_2.20H_2O$	Oct	{111} dist.	White	H=5 G=1.92	Zeolite group. Decpd. by acid. F=3. Uniax. + in eight segments from loss of H_2O.
1.483	Sodalite $3Na_2O.3Al_2O_3.6SiO_2.2NaCl$	Dodec	{110} poor	Gray, blue, etc.	H=6 G=2.2±	Sodalite group. Gelat. F=3.5 to 4.0.
1.485	Evansite $3Al_2O_3.P_2O_5.18\pm H_2O$	Amor. Concretions.		Colorless	H=4 G=1.94	Sol. only in hot H_2SO_4. Infus.
1.486	Cristobalite SiO_2	Ps.isomet. Oct.		White	H=6 to 7 G=2.3	Insol. in acid. Infus. B=0.005. Intricate tw.
1.487	Analcite $Na_2O.Al_2O_3.4SiO_2.2H_2O$	{211}	{100} tr.	Colorless	H=5 G=2.25	Zeolite group. Decpd. by acid. F=3.5. Opt. anom.
1.487	Hackmanite $3Na_2O.3Al_2O_3.6SiO_2.2NaCl$ Some S replaces Cl_2.	Dodec	{110} poor	Reddish violet, fading on exposure.	H=5 G=3.32(?)	Sodalite group. Near sodalite. Gelat. F=4.

1.49±	Vashegyite $3Al_2O_3.2P_2O_5.18\pm H_2O$	Amor		White, yellowish, green.	H=3.5 G=1.98	Sol. in acid. Infus.
1.49	Allophane $Al_2O_3.SiO_2.nH_2O$	do	Hyaline-like	Blue, green, etc	H=3 G=1.86	Gelat. Infus.
1.490	Sylvite KCl	Plagihedral	Cubic perf.	Colorless	H=2 G=1.99	Sol. in H_2O. Tastes bitter. F=1.5.
1.495	Noselite $5Na_2O.3Al_2O_3.6SiO_2.2SO_3$	Dodec.	{110}poor	Blue, etc	H=6 G=2.3±	Sodalite group. Gelat. F=4.5.
1.496	Haüynite $5(Na_2,Ca)O.3Al_2O_3.6SiO_2.2SO_3$	do	do	do	H=6 G=2.4	Do.
1.50±	Lazurite $3Na_2O.3Al_2O_3.6SiO_2.2Na_2S$	do	do	Azure blue	H=6 G=2.4	Sodalite group. Gelat. F=3.5. Anom. disp. $n_{Li}=1.63$, $n(520\ \mu\mu)=1.51$, $n(450\ \mu\mu)=1.535$.
1.5	Rosiérésite Hydrous phosphate of Al, Pb, and Cu.	Amor. Compact, stalactitic.		Yellow	G=2.2	Near evansite. Easily sol. in HNO_3. Infus. but blackens b. b.
1.508	Tychite $2MgO.3Na_2O.4CO_2.SO_3$	Oct.	None	Colorless	H=3.5 G=2.46 to 2.59	Compare with northupite. Almost insol. in H_2O; sol. in acids. F=1.
1.50±	Stevensite $3MgO.4SiO_2.nH_2O$	Amor	do			
1.509	Leucite $K_2O.Al_2O_3.4SiO_2$	Ps. isomet.{211}	Imperf	Colorless, etc	H=5.5 G=2.47	Decpd. by acid. Infus. Birefracting below 500° C Twin lamellae. Symmetrical inclusions.
1.514	Northupite $MgO.Na_2O.2CO_2.NaCl$	Oct.	None	do	H=4 G=2.38	Slightly sol. in H_2O; sol. in acid. F=1. Tw. common.
1.51±	Hisingerite $Fe_2O_3,MgO,FeO,SiO_2,H_2O$,etc.	Amor	Conch	Black or brownish black.	H=3 G=2.5 to 3	Decpd. by acids. Infus. Opal-like. In part finely crystalline.
1.517	Planerite $3Al_2O_3.2P_2O_5.18\pm H_2O$	do	None	Green	H=1.5 to 5 G=2.65	Slightly sol. in acid. B. b. decrepitates. In part birefracting.
1.517	Meerchaum $2MgO.3SiO_2.nH_2O(?)$	do	do	White	Soft	Amorphous part of sepiolite.
1.52±	Halloysite $Al_2O_3.2SiO_2+nH_2O$	Amor., earthy	do	White, yellow	H=1 to 2 G=2.0 to 2.2	Insol. in acid. Infus. On drying at about 60° C. n increases to 1.555.
1.52	Hydrophilite $CaCl_2$	Cubes		White	Soft G=2.2	Very deliquescent. F=1.5.
1.525	Pollucite $2Cs_2O.2Al_2O_3.9SiO_2.H_2O$	do		Colorless	H=6.5 G=2.90	Related to leucite. Decpd. by acid. F=dif.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.53±	Spadaite $5MgO.6SiO_2.4\pm H_2O$	Amor		Reddish	H=2.5	Gelat. F=4(?).
1.53±	Kehoeite $3(Zn,Ca)O.2Al_2O_3.P_2O_5.27\pm H_2O$	Amor., chalky		White	G=2.34	Sol. in acid. Infus.
1.535±	Succinite Hydrocarbon.	Amor	Conch	Amber-yellow, vitreous luster.	Soft G=1.07	Amber. F=easy.
1.54±	Neotocite $MnO.SiO_2.nH_2O$	do	do	Brown to black	H=4 G=2.7	Decpd. by acid. F=dif.
1.535	Langbeinite $K_2O.2MgO.3SO_3$	Highly modified tetrah.		Colorless	H=3 to 4 G=2.83	Sol. in H_2O. Absorbs H_2O in air. F=2.
1.54±	Cornuite $mCuO.nSiO_2.H_2O$	Amor	None	Bluish green		
1.542±	Halloysite $Al_2O_3.2SiO_2.nH_2O$	do		White	H=2 G=2.6	Insol. in acid. Infus. On drying at about 60° C. *n* increases to 1.555.
1.544	Halite NaCl	Cubes	Cubic perf	Colorless	H=2.5 G=2.17	Sol. in H_2O. F=1.5.
1.548±	Leverrierite(?) $Al_2O_3.4SiO_2.6H_2O(?)$			White	Soft G=1.73	Uncertain. Decpd. by H_2SO_4. Infus.
1.555	Halloysite $Al_2O_3.2SiO_2.2H_2O$	Amor. powder		do	H=2 G=2.6	Insol. in acid. Infus.
	Scacchite $MnCl_2$	Cubic				Deliquescent.
1.569	Collophanite CaO,P_2O_5,H_2O,CO_2, etc.	Amor		do	H=2 to 2.5 G=2.7 to 2.8	Sol. in acid. F=5(?).
1.57±	Zaratite $3NiO.CO_2.nH_2O(?)$	do	Conch	Emerald-green	H=3 G=2.6	Banded. *n* varies from 1.56 to 1.61.
1.571	Nitrobarite $BaO.N_2O_5$	Isomet. Oct.		Colorless	G=3.25(?)	Sol. in H_2O. F=1.

1.584	Schroetterite $8Al_2O_3.3SiO_2.30\pm H_2O$	Amor		White	H=3 to 3.5 G=1.95 to 2.05	Uncertain clay mineral.
1.589	Zunyite $8Al_2O_3.6SiO_2.9H_2(O,F_2,Cl_2)$	Tetrah	{111}	Colorless	H=7 G=2.88	Insol. in acid. Infus.
1.59±	Hisingerite $Fe_2O_3,MgO,FeO,SiO_2,H_2O$, etc.	Amor	Conch	Black or brownish black.	H=3 G=3	Decpd. by acid. Infus. Opal-like. In part finely crystalline.
1.59±	Zaratite $3NiO.CO_2+nH_2O$(?)	do	do	Emerald-green	H=3 G=2.6±	n varies from 1.56 to 1.61.
1.59±	Collophanite CaO,P_2O_5,CO_2,H_2O, etc.	do		White, etc	H=2 G=2.7±	Easily sol. in acid. F=5(?)
1.59	Garnierite $(Ni,Mg)O.SiO_2.nH_2O$	Submicroscopic		Bright green	H=2± G=2.6±	A serpentine. Decpd. by HCl. Infus.
1.60±	Stibiconite $Sb_2O_4.nH_2O$(?)	Amor	Conch	Gray, yellow, colorless.	H=4 to 5 G=5±	Insol. in acid. Infus. n highly variable. (See p. 136.)
1.60±	Borickite $3CaO.7Fe_2O_3.2P_2O_5.24\pm H_2O$(?)	do	do	Reddish brown	H=3.5 G=2.7±	Sol. in acid. F=3 to 4. n varies from 1.57 to 1.67.
1.602	Voltaite $5(Mg,Fe,K_2)O.2(Al,Fe)_2O_3.10SO_3.15H_2O$	Oct., etc	None	Dull oil-green, brown, black.	H=3 to 4 G=2.79	Partly sol. in H_2O; sol. in acid. In section oil-green.
1.61±	Zaratite $3NiO.CO_2.nH_2O$(?)	Amor	Conch	Emerald-green.	H=3 G=2.6±	n varies from 1.56 to 1.61.
1.61±	Diadochite $2Fe_2O_3.P_2O_5.2SO_3.2H_2O$	do		Brown, yellow	H=3 G=2.03±	Sol. in HCl. F=easy.
1.61±	Collophanite CaO,P_2O_5,H_2O,CO_2, etc.	do		White	H=2 G=2.9±	Sol. in HCl. F=5 (?).
1.61±	Gummite $(Pb,Ca,Ba)O.3UO_3.SiO_2.5H_2O$	do	Gumlike	Yellow, red, etc	H=2.5 G=4.0±	Sol. in acid. Infus. Greasy. Alteration of uraninite. May be crystalline.
1.635±	Pitticite $Fe_2O_3,SO_3,As_2O_5,H_2O$, etc.	do		Brown, yellowish, white.	H=2.3 G=2.3	Sol. in HCl. F=easy.
1.64±	Griphite MnO,P_2O_5,H_2O, with Fe,Al, Ca, etc.	Amor., resinous	Conch	Brown	H=5.5 G=3.4	Do.
1.64±	Lagonite $Fe_2O_3.3B_2O_3.3H_2O$	Amor., earthy		Ocher-yellow	Soft	
1.640	Homilite (altered) $3(Ca,Fe)O.B_2O_3.2SiO_2.nH_2O$(?)	Ps. mon. {Tab.001}	Conch	Black	H=5 G=3.35	

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.642	Sal ammoniac NH_4Cl	Isomet	{111}imperf	Colorless	H=1.5 to 2 G=1.53	Sol. in H_2O. F=1. Volatile.
1.65±	Koninckite $Fe_2O_3.P_2O_5.6\pm H_2O$	Amor.(?)		Yellow	H=3.5 G=2 to 3	Sol. in strong acid. F=3.
1.65	Equeiite $6Fe_2O_3.CaO.5\frac{1}{3}P_2O_5.23\pm H_2O$	Amor		Yellow-brown	H=fragile G=2.66	Sol. in acid. F=1.
1.67±	Borickite $3CaO.7Fe_2O_3.2P_2O_5.24\pm H_2O$	do	Conch	Reddish brown	H=3.5 G=2.7±	Sol. in acid. F=3 to 4. *n* varies from 1.57 to 1.67.
1.67	Hibschite $CaO.Al_2O_3.2SiO_2.2H_2O$	Oct		Colorless	H=6 G=3.05	Sol. in acid. Infus. Some crystals B and divided into sectors.
1.676	Pharmacosiderite $3Fe_2O_3.2As_2O_5.3(H,K)_2O.5H_2O$	Cubes and tetrah	{100}imperf	Brown, green, etc.	H=2.5 G=3.0	Sol. in HCl. F=1. Anom. B.
1.68±	Allanite $4(Ca,Fe)O.3(Al,Ce,Fe,Di)_2O_3.6SiO_2.H_2O$	Ps. mon.(?)	Imperf	Brown, black	H=6 G=3.5 to 4.2	Epidote group. Alters to a brown, birefracting form. May gelat. F=3.
1.69	Rhodizite $(K,Cs,Rb)_2O.2Al_2O_3.3B_2O_3$	Oct., etc		Colorless	H=8 G=3.40	Insol. in acid. Infus. Opt. anom.
1.69	Thorite (altered) $ThO_2.SiO_2.nH_2O$	Ps. tetrag. Sq. pyramids.	{110}dist	Black, brown, green, orange.	H=4.5 to 5 G=5.2 to 5.4	Gelat. Infus. Isot. from alteration or inversion.
1.7±	Stibiconite $Sb_2O_4.nH_2O(?)$	Amor	Conch	Gray, etc	H=4 to 5 G=5.00	Insol. in acid. Infus. *n* highly variable.
1.70	Polycrase Columbate and titanate of Y, U, Th, Fe, etc.	Ps. orth. Thin pris. c. Tab.{010}	do	Dark brown to black.	H=5 to 6 G=5.00	Blomstrandine group. Decpd. by H_2SO_4. Infus.
1.705	Pyrope $3MgO.Al_2O_3.3SiO_2$	Isomet {110}{211}etc.	None	Red	H=7 G=3.510	Garnet group. Data for pure mineral. Insol. in acid. $F=3\frac{1}{2}$.
1.710	Plazolite $3CaO.Al_2O_3.(SiO_2,CO_2).2H_2O$	Rhombic dodec	do	Colorless	H=6.5 G=3.13	

1.72±	Allanite $4(Ca,Fe)O.3(Al,Ce,Fe,Di)_2O_3.6SiO_2.H_2O$	Ps. mon.(?)	Imperf.	Brown, black	H=6 G=3.5 to 4.2	Epidote group. Alters to a brown, birefracting form. May gelat. F=3.
1.723±	Spinel $MgO.Al_2O_3$	Oct.	{111}imperf.	Red, etc.	H=8 G=3.6±	Spinel group. Insol. in acid. Infus. Tw. after {111}. *n* is for the pure artificial mineral.
1.725	Rowlandite $2Y_2O_3.3SiO$		Conch.	Drab-green to red.	H=6 to 7 G=4.52	Near gadolinite. Gelat. Infus. Pale green in splinters.
1.727	Berzeliite $3(Ca,Mg,Mn)O.As_2O_5$	Isomet.	None.	Sulphur - yellow to orange-yellow.	H=5 G=4.05	Sol. in acid. F=3.
1.735	Grossularite $3CaO.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	do.	Varies.	H=6 G=3.530	Garnet group. Insol. in acid. F=3. Opt. anom. Data for pure mineral.
1.736	Periclase MgO	Isomet. Cubes, oct.	{100} perf., {111} poor.	Colorless	H=5 G=3.6	Sol. in acid. Infus.
1.737	Danalite $3(Fe,Zn,Mn)O.3GlO.3SiO_2.(Fe,Zn)S$	Isomet. Ps. oct.		Red to gray	H=6 G=3.43	Near helvite. Gelat. F=3.
1.739	Helvite $3(Mn,Fe)O.3GlO.3SiO_2.MnS$	Isomet. Tetrah.	{111} tr.	Yellow, etc.	H=6 G=3.2	Gelat. F=3.
1.74±	Pilbarite $UO_2.ThO_2.PbO.2SiO_2.4H_2O$	Amor. Gumlike.			H=3 G=4.6±	Sol. in acid.
1.74±	Caryocerite (altered) Silicate of Y,Ce,Ca,etc., containing F and B.	Ps. trig. Tab. rhombs.	Conch.	Nut-brown	H=5 to 6 G=4.30	Near melanocerite. Sol. in hot HCl with separation of SiO_2. B. b. swells without fusing. Isotropic through alteration.
1.742	Pyrope $3(Mg,Fe)O.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	None.	Red	H=7 G=3.715	Garnet group. Insol. in acid. F=3.5. Data for mineral with percentages of Cr_2O_3=2.4, FeO=10.2, MgO=18.4, CaO=4.5, MnO=0.5.
1.75±	Spinel $(Mg,Fe)O.Al_2O_3$	Isomet. {111}, rarely {100}.		Black, green in section.	H=7.5 G=3.75±	Spinel group. Insol. in acid. Infus.
1.755	Arsenolite As_2O_3	Isomet. Oct.		White	H=1.5 G=3.70	Sol. in H_2O. F=1. Volatile.
1.757±	Tritomite (altered) Silicate of Th, Ce, Y, Ca, etc., containing F and B.	Ps. trig.	Indist.	Dark brown	H=5.5 G=4.2	Gelat.
1.758	Yttrialite $(Y,Th)_2O_3.2SiO_2$	Ps. orth. Pris.	Conch.	Black, brown, olive green.	H=5 to 7 G=4.58	Sol. in HCl. Infus. Pale green in section.
1.760	Rhodolite $3(Mg,Fe)O.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	None.	Dark red, etc.	H=7 G=3.837	Garnet between pyrope and almandite. Insol. in acid. Infus. Data for mineral with percentages of Fe_2O_3=1.9, FeO=15.6, CaO=0.9, MgO=17.2.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.763	Hessonite $3CaO.(Al,Fe)_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	None	Brown	H=6 G=3.633	Garnet group near grossularite. Insol. in acid. F=3. Data for mineral with percentages of Fe_2O_3=7.2, MnO=0.1.
1.77±	Melanocerite (altered) Ce,Y,Ca,B,Fe,Si,etc.	Ps. trig. Tab. {0001}.	Conch	Deep brown to black.	H=5 to 6 G=4.13	Sol. in acid. In section reddish brown.
1.77	Mackintoshite Silicate of U, Th, Ce, etc., containing H_2O.	Ps. tetrag. Sq. prisms.		Black	H=5.5 G=5.44	Difficultly sol. in acids. Infus. In section nearly colorless but clouded.
1.77±	Pleonaste $(Mg,Fe)O.Al_2O_3$	Isomet. {111}, rarely {100}.	None	do	H=7.5 G=3.8±	Spinel group. Insol. in acid. Infus. Grass-green in section.
1.778	Almandite $3FeO.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.		Dark red, etc	H=7 G=4.04	Garnet group. Insol. in acid. F=3. Data for mineral with percentages of Fe_2O_3=3.3, MnO=1.2, CaO=2.5, MgO=1.1.
1.780±	Gadolinite $2GlO.FeO.Y_2O_3.2SiO_2$	Ps. mon	Conch	Black, greenish black.	H=6.5 to 7 G=4.0 to 4.5	Gelat. Infus. On ignition becomes birefracting and *n* increases to 1.820.
1.80±	Hercynite $FeO.Al_2O_3$	Isomet. Oct	Imperf	Black	H=7.5 G=3.9	Spinel group. Insol. in acid. Infus. Grass-green in section.
1.800	Spessartite $3MnO.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	Conch	Colorless, reddish	H=7 G=4.180	Garnet group. Data for pure mineral. Insol. in acid. F=3.
1.80±	Gahnite $ZnO.Al_2O_3$	Isomet. Oct	{111} imperf	Colorless	H=7.5 to 8 G=4.55	Spinel group. Insol. in acid. Infus.
1.8±	Stibiconite $Sb_2O_4.nH_2O$(?)	Amor	Conch	Gray, yellow, etc.	H=4 to 5 G=5±	Insol. in acid. Infus. *n* very variable.
1.801	Almandite $3FeO.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	{110} poor	Dark red, etc	H=7 G=4.093	Garnet group. Insol. in acid. F=3. Data for mineral with percentages of MnO=1.5, CaO=2.0, MgO=5.3.
1.811	Spessartite $3(Mn,Fe)O.Al_2O_3.3SiO_2$	do	None	Colorless, reddish	H=7 G=4.273	Garnet group. Insol. in acid. F=3. Data for mineral with percentages of FeO=11.1, MnO=32.2, CaO=0.6, MgO=0.2.

1.812	Beckelite $3CaO.2(Ce, La, Di)_2O_3.3SiO_2$	Isomet. Dodec. Oct.	{100} dist	Light yellow, brown.	H=5 G=4.14	Sol. in HCl. Infus. Large crystals are anisotropic. In section yellow.
1.818	Naegite ZrO_2,SiO_2, with $UO_3,ThO_2,(Cb,Ta)_2O_5,Y_2O_3$.	Spheroidal aggregates. Dodecahedral.	Conch	Dark green or brown.	H=7.5 G=4.09	Probably related to zircon or malacon.
1.826	Malacon $ZrO_2.SiO_2.nH_2O$	Sq. prisms		Colorless	H=3 G=4.0 to 4.3	Altered zircon.
1.83	Romeite $5CaO.3Sb_2O_5$	Isomet. Oct.	Conch	Yellow	H=5.5 G=5.04	Insol. in acid. F=dif. Opt. anom. with low B.
1.83	Lime CaO	Isomet. Cubes	{100} perf	Colorless	H=3 to 4 G=3.32	Sol. in acid; somewhat sol. in H_2O. Rapidly alters on exposure to moist air.
1.830	Almandite $3FeO.Al_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	{110} poor	Dark red, etc.	H=7 G=4.250	Garnet group. Insol. in acid. F=3. Data for pure mineral.
1.838	Uvarovite $3CaO.Cr_2O_3.3SiO_2$	do.	None	Emerald-green	H=7.5 G=3.418	Garnet group. Opt. anom. Insol. in acid. Infus. Data for mineral with percentages of Al_2O_3=5.9, Cr_2O_3=22.5.
1.865	Andradite $3(Ca,Mg,Fe)O.Fe_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	do.	Varies	H=7 G=3.781	Garnet group. Gelat. imperfectly. F=3.5. Data for mineral with percentages of Al_2O_3=6.1, Fe_2O_3=25.1, FeO=0.8, CaO=33.7.
1.86±	Bindheimite Hydrous antimonate of Pb.	Amor., opal-like	Conch	Gray, green, etc.	H=4 G=4.8±	F=3 to 4.
1.87±	Romeite $5(Ca,Mn)O.3Sb_2O_5$	Isomet. Oct.	do.	Yellow	H=5.5 G=5.07	Insol. in acid. F=dif. Opt. anom. with low B.
1.87±	Chalcolamprite Contains Cb, Si, Zr, Ce, Ca, Na, F, O, etc.	do.		Grayish brown	H=5 to 6 G=3.77	Near pyrochlore.
1.88	Tscheffkinite Titanosilicate of Ce, Fe, etc.	Ps. mon.	Conch	Velvet-black	H=5 G=4.3 to 4.55	Gelat. F=4. Red-brown in section. In part birefracting and opt. −.
1.895	Andradite $3CaO.Fe_2O_3.3SiO_2$	Isomet. {110}, {211}, etc.	do.	Yellow, green, brown, black, etc.	H=7 G=3.750	Garnet group. Gelat. imperfectly. F=3.5. Data for pure mineral.
1.9±	Stibiconite $Sb_2O_4.nH_2O(?)$	Amor	do.	Gray, yellow, etc.	H=4 to 5 G=5	Insol. in acid. Infus.
1.92±	Betafite Columbate and titanate of uranium, etc.	Isomet. Oct.	do.	Greenish black	H=5 G=4	
1.925	Microlite $6CaO.3Ta_2O_5.CbOF_3$	do.		Yellow, brown, red, etc.	H=5.5 G=5.51±	Pyrochlore group. Decpd. by H_2SO_4. Infus. On ignition *n* changes to 2.040.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.93	Nantokite Cu_2Cl_2	Isomet	{100}	Colorless	H=2 G=3.93	Sol. in H_2O. Fus. Oxidizes rapidly. Data on artificial crystals.
1.94	Melanite $3CaO.(Fe,Ti)_2O_3.3(Si,Ti)O_2$	Isomet. {110}, {211}, etc.	Conch	Black	H=7 G=3.7	Garnet group. Gelat. F=4. TiO_2=8.7 per cent.
1.94	Samirésite Columbate of U, etc.	Isomet. Oct		Golden yellow	Friable G=5.24	
1.96±	Neotantalite $(Ta, Cb)_2O_5$, H_2O, etc.	do		Clear yellow	H=5 to 6 G=5.19	
1.96	Pyrochlore Columbate and titanate of Ce, Ca, etc., with Th, F, etc.	do	{111} variable	Brown	H=5 G=4.3±	Pyrochlore group. Decpd. by H_2SO_4. Infus. On ignition n increases to 2.000. Opt. anom.
1.965	Tscheffkinite Titanosilicate of Ce, Fe, etc.	Ps. mon	Conch	Velvet-black	H=5 G=4.3 to 4.55	Gelat. F=4. Red-brown in section. In part birefracting and opt. −.
1.98±	Hatchettolite Tantalocolumbate of U, Ca, etc.	Isomet. Oct		Brown	H=5 G=4.8±	Pyrochlore group. Insol. in acid. Infus.
1.98	Schorlomite $3CaO.(Fe,Ti)_2O_3.3(Si,Ti)O_2$	Isomet. {110}, {211}, etc.	Conch	Black	H=7 G=3.85±	Garnet group. Gelat. F=4. TiO_2=16.9 per cent.
1.99±	Stibiconite $Sb_2O_4.nH_2O$(?)	Amor	do	Yellow, gray	H=4 to 5 G=5	Insol. in acid. Infus.
2.0±	Wiikite Columbate, titanate, and silicate of Fe and rare earths.		do	Black	H=6 G=3.8 to 4.8	Infus.
2.00	Pyrochlore Columbate and titanate of Ca, Ce, etc., with Th, F, etc.	Isomet. Oct	{111} variable	Brown, dark red	H=5 G=4.3	Pyrochlore group. Decpd. by H_2SO_4. Infus. After ignition n=2.227.
2.01	Ivaarite Near schorlomite, etc.	Isomet. {110}, {211}, etc.	Conch	Black	H=6 G=3.7	Garnet group. Gelat. F=4. TiO_2=25 per cent.
2.05	Percylite $PbO.CuCl_2.H_2O$	Isomet. Cubic	{100}	Pale blue	H=2 G=5.25	Sol. in HNO_3. F=1. In section sky-blue.

2.05±	Picotite $(Mg,Fe)O.(Al,Cr)_2O_3$	Isomet. Oct.	None	Brown	G=4.08	Spinel group. Nearly insol. in acid. Infus.
2.05	Eulytite $2Bi_2O_3.3SiO_2$	Isomet. Tetrah	{110}imperf.	Brown, yellow, gray	H=4.5 G=6.11	F=2. Optic anomalies. Uniax.—.
2.05±	Risorite $Cb_2O_5.(Y,Er)_2O_3.H_2O$; some Ta, Ti, Ce, La, etc.		Conch.	Dark brown	H=5.5 G=4.18	Easily sol. in hot conct. H_2SO_4. Reddish brown in section.
2.06±	Sipylite Columbate of Er, La, Di, U, etc.	Ps. tetrag. Oct.	{111} dist. Conch.	Brownish black, brownish orange.	H=6 G=4.89	Insol. in acid. Infus. Pale red-brown in section.
2.05±	Limonite $Fe_2O_3.nH_2O$	Amor	None	Ocher-yellow	H=4± G=3.8±	Sol. in HCl. Infus.
2.06±	Euxenite Columbate and titanate of Yt, Er, Ce, U, etc.	Ps. orth.	Conch.	Brownish black	H=6.5 G=4.6 to 5.0	Blomstrandine group. Insol. in acid. Infus. Reddish brown in powder. After ignition $n=2.22$.
2.061	Cerargyrite AgCl	Isomet. Cubes	None	Gray, etc.	H=1 to 1.5 G=5.55	Sectile. Sol. in ammonia. F=1.
2.065	Mosesite Hg, NH_4, Cl, SO_3, H_2O	Isomet. Oct.	Conch.	Pale lemon-yellow.	Soft.	In part abnormally birefracting.
2.070	Chromite $FeO.Cr_2O_3$	Isomet. Oct. Massive.	do.	Iron-black to brownish black.	H=5.5 G=4.5	Spinel group. Insol. in acids. Infus. in oxygen flame. Nearly opaque.
2.087	Senarmontite Sb_2O_3	Isomet. Oct.	{111}tr.	Colorless	H=2 G=5.2	Sol. in HCl. F=1.5, volatile. Anom. B.
2.09	Schneebergite $4(Ca, Fe)O.2Sb_2O_4$	do.	{111}dist.	Honey-yellow	H=6.5 G=5.41	Insol. in acids. F=dif. Opt. anom. with low B.
2.115±	Fergusonite $(Y, Er, Ce)_2O_3.(Cb, Ta)_2O_5$	Ps. tetrag. Pyramidal.	{111}imperf. Conch.	Brownish black	H=6 G=5.8	Decpd. by H_2SO_4. Infus. After ignition becomes anisotropic with $n=2.070$. Brown in powder.
2.13	Ampangabéite Columbite of U, etc.	Ps. orth. Rectangular prisms.	Conch.	Brownish red	H=4 G=3.97 to 4.29	Easily sol. in acid. Fuses to a black slag. In section red-brown.
2.13±	Yttrocrasite Hydrous titanate of Th, Y, etc.	Ps. orth.	do.	Black	H=6 G=4.80	Sol. in H_2SO_4. Infus. In section amber. In part faintly birefracting.
2.142	Blomstrandine Columbate and titanate of U, Th, Y, Er, Ce, etc.	Ps. orth. Tab. {010}. Elong.	do.	do.	H=5.5 G=4.8 to 5.0	Blomstrandine group. After ignition $n=2.24$.
2.15	Yttrotantalite $(Ca, Fe)O.(Y, Er, Ce, etc.)_2O_3.2(Ta, Cb)_2O_5.4H_2O$	Ps. orth.	{010}imperf. Conch.	Black to straw-yellow.	H=5 G=5.7±	In section red-brown.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.15±	Koppite 2(Ca, Ce, etc.)O.Cb_2O_5.2/5NaF	Isomet. Dodec.	Conch.	Brown.	H=5.5 G=4.5	Pyrochlore group. Decpd. by H_2SO_4. Infus. In section red.
2.15±	Embolite Ag(Br, Cl)	Isomet. Cubes.		Colorless.	H=1 to 1.5 G=5.4	Sol. in ammonia. F=1. Isomorphous with cerargyrite and bromyrite. Sectile.
2.16	Chromite FeO.Cr_2O_3	Isomet. Oct. Massive.		Iron-black to brownish black.	H=5.5 G=4.5	Spinel group. Insol. in acids. Infus. in oxygen flame.
2.16	Manganosite MnO	Isomet. Oct.	{100}.	Emerald-green; nearly black in mass.	H=5 to 6 G=5.18	Sol. in acid. Infus. In powder and section emerald-green.
2.175±	Fergusonite (Y, Er, Ce)$_2O_3$.(Cb, Ta)$_2O_5$	Ps. tetrag. Pyramidal.	{111}imperf. Conch.	Black.	H=6 G=5.8±	Decpd. by H_2SO_4. Infus. After ignition becomes B. with n=2.142.
	Uhligite CaO.Al_2O_3.ZrO.2TiO_2	Isomet. Oct.	{100}imperf.	do.		Near zirkelite. Translucent on thin edges.
2.19	Zirkelite (Ce, Fe, Ca)O.2(Zr, Ti, Th)O_2	do.	Conch.	do.	H=5.5 G=4.72	Insol. in acid. Infus. Clear reddish brown in section.
2.195±	Fergusonite (Y, Er, Ce)$_2O_3$.(Cb, Ta)$_2O_5$	Ps. tetrag. Pyramidal.	do.	do.	H=5.5 to 6 G=5.8	Decpd. by H_2SO_4. Infus. On ignition becomes anisotropic with n=2.090.
2.195±	Euxenite Columbate and titanate of Y, Er, Ce, U, etc.	Ps. orth.	do	Brownish black.	H=6.5 G=4.8	Blomstrandine group. Insol. in acid. Infus. In section reddish brown. After ignition n=2.23.
	Oldhamite CaS	Isomet.	{100}.	Pale brown.	H=4 G=2.58.	Soluble in acid. Rapidly oxidizes in air.
2.20	Lewisite 5CaO.2TiO_2.3Sb_2O_5	Isomet. Oct.	{111} nearly perf.	Honey-yellow; colophony-brown.	H=5.5 G=4.95	Insol. in acids. F=easy.
2.20±	Bismutite $Bi_2O_3.CO_2.nH_2O$	Amor. opaline.	Conch.	Gray, etc.	H=4 to 5 G=7±	Effervesces with acid. F=1.5. In part cryptocrystalline.
2.20±	Thorianite ThO_2,U_3O_8, etc.	Isomet. Cubes		Black.	G=9.32	Nearly opaque.
2.20	Iodobromite 2AgCl.2AgBr.AgI	do.	{111} dist.	Colorless, etc., yellow.	H=1 G=5.7	Compare with cerargyrite, etc. Sol. in ammonia. F=1. Sectile.

2.20	Miersite $CuI.4AgI$	Isomet. Cubes, etc.		Yellow	H=2 G=5.64	Sol. in ammonia. F=1. Tw. pl. {111}. Sectile.
2.205	Eschynite $2(Ca,Fe)O.2Ce_2O_3.8TiO_2.3Cb_2O_5$	Ps. orth.	Conch.	Brownish black	H=5.5 G=5.0±	Insol. in acid. Infus. In section reddish brown.
2.21±	Samarskite $3(Fe,Ca,UO_2,etc.)O.(Ce,Y,etc.)_2O_3.3(Cb,Ta)_2O_5$	Ps. orth. Pris.	{010} imperf. Conch.	Velvet-black	H=5 to 6 G=5.6 to 5.8	Nearly insol. in acids. F=5. In section brownish to opaque. Sensibly isotropic to strongly birefracting.
2.215	Polymignite Columbate, titanate, zirconate of Ce, etc.	do	{100} {010} tr. Conch.	Black	H=6.5 G=4.8	Infus. Reddish brown in section.
2.24±	Euxenite Columbate, titanate of Y, Er, U, Ce, etc.	Isomet. Oct.	Conch.	Brownish black	H=6.5 G=5.0±	Blomstrandine group. Insol. in acid. Infus. In section reddish brown.
2.25±	Samarskite $3(Fe,Ca,UO_2,etc.)O.(Ce,Y,etc.)_2O_3.3(Cb,Ta)_2O_5$	Ps. orth.	{010} imperf. Conch.	Black	H=5 to 6 G=5.6 to 5.8	Nearly insol. in acid. F=5. In section brownish to opaque. Isotropic to strongly birefracting.
2.18 red 2.39 blue	Bunsenite NiO	Isomet. Oct.		Green or brownish black.	H=5.5 G=6.4	Sol. in acid. Infus.
2.253	Bromyrite $AgBr$	Isomet. Cubes, etc.	{110} poor	Yellow, etc.	H=2 G=5.9	Sol in ammonia. F=1. Sectile.
2.26±	Eschynite $2(Ca,Fe)O.2Ce_2O_3.8TiO_2.3Cb_2O_5$	Ps. orth	Conch.	Brownish black	H=5 G=5.1	Insol. in acid. Infus. Reddish brown in section. On ignition becomes birefracting with n=2.285.
2.26±	Bismutite $Bi_2O_3.CO_2.nH_2O(?)$	Amor	Powder	Gray, yellow	H=4 G=6.9 to 7.7	Effervesces in acid. F=1.5.
	Monimolite $3RO.Sb_2O_5$. R=Pb:Fe=3:1	Oct. or cubes	{111} dist	Yellowish or brownish green to brown or black.	H=5 to 6. G=6.58 to 7.29	Insol. in acid. Fuses to a black slag. Weak anom. B.
2.30	Brannerite Chiefly $TiO_2,UO_3,UO_2,ThO_2,Y_2O_3$, $(Ca,Fe)O$.	Ps. tetrag.	Conch.	Black	H=7 G=5.1	Sol. in acid. Light reddish brown in transmitted light.
2.30	Knopite $(Ca,Y,Fe,Ce)O.TiO_2$	Isomet. Cubes	{100}	do	H=5 G=4.2±	Near perofskite. Brownish in powder. Anom. B. with B=low.
2.33	Dysanalite $7(Ca,Ce,Fe,Na_2)O.6TiO_2.Cb_2O_5$	do	do	Iron-black	H=5 to 6 G=4.13	Near perofskite. Compare with the pyrochlore group (pp. 179–182). Decpd. by HCl with difficulty. Infus. Nearly opaque. In part anisotropic, with B=weak.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Isotropic group—Continued.

n.	Mineral name and composition.	Crystal system and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.346	Marshite Cu_2I_2	Isomet. Tetrah.	{110}	Oil-brown, etc.	H=2.5 G=5.59	F=1.5(?). Dispersion exceeds that of diamond.
2.35_{Li}	Magnesioferrite $MgO.Fe_2O_3$	Isomet. Oct.	None	Black to dark red in powder.	H=6 to 6.5 G=4.6	Difficultly sol. in acid. Infus. Magnetic. In transmitted light dark red.
2.36_{Li}±	Franklinite $(Zn,Fe,Mn)O.(Fe,Mn)_2O_3$	do	do	Iron-black	H=6 G=5.1	Spinel group. Sol. in hot HCl. Infus. Nearly opaque in reddish brown.
2.37_{Na} 2.34_{Li}	Sphalerite ZnS (pure)	Isomet. Tetrah.	{110}perf.	Colorless to pale yellowish.	H=3.5 to 4 G=4.0	Luster resinous. Sol. in HCl. F=5. Data on pure ZnS.
2.38	Perofskite $CaO.TiO_2$	Cubic	{100}rather poor	Yellow, etc.	H=5.5 G=4.03	Decpd. by acid with difficulty. Infus. Anom. B. with complex tw.
2.419	Diamond C	Isomet. Tetrah.	{111}highly perf.	Colorless, etc.	H=10 G=3.52	Insol. in acid. Infus. Tw. pl. {111}.
2.47_{Na}	Sphalerite $72ZnS+28FeS$	do	{110}perf.	Brown to black	H=3.5 to 4 G=4.0	Luster resinous. Sol. in HCl. F=5.
2.49_{Li}	Eglestonite $Hg_2Cl_2.HgO$	Isomet.	None	Yellow, darkens on exposure.	H=2 to 3 G=8.33	Decpd. by acid. Volatile. Anom. B.
2.69_{Li}	Hauerite MnS_2	Isomet. Oct. pyritohedrons.	{100}imperf.	Brownish black	H=4 G=3.66	Sol. in HCl. F=3. Red in powder.
2.70_{Li}	Alabandite MnS	Isomet. Cubes, dodec., etc.	{100}perf.	Iron-black	H=3.5 to 4 G=4.0	Sol. in HCl. F=3. Streak green.
2.849	Cuprite Cu_2O	Isomet. Plagihedral.	{111}interrupted	Red	H=3.5	Streak crimson. Sol. in pure H_2SO_4. F=3.
>2.72_{Li}	Tetrahedrite $5Cu_2S.2ZnS.2Sb_2S_3$	Isomet. Tetrah. Massive. Tw. pl. {111} and {100}.	None	Flint-gray to iron-black.	H=3 G=4.6±	Decpd. by HNO_3. F=1.5. In section bright red to opaque.
>2.72_{Li}	Tennantite $5Cu_2S.2ZnS.2As_2S_3$	Isomet. Dodec., etc.		Iron-black, cherry-red in splinters.	H=3 G=4.6±	Nearly opaque. Decpd. by HNO_3. F=1.5.

Uniaxial positive group.

[The greater part of the minerals of this group are tetragonal or hexagonal, but some minerals that are strictly biaxial but with nearly zero axial angle are included here as well as in their proper biaxial group. A considerable proportion of these biaxial minerals with nearly uniaxial optical properties have also nearly hexagonal crystal form.]

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.313	1.309	Ice H_2O	Hex. Massive		Colorless	H=1.5 G=0.917	
1.390	1.378	Sellaite MgF_2	Tetrag. Pris.	{100}{110}perf	do.	H=5 G=3.0±	Sol. in conct. H_2SO_4. F=4 to 5 with intumescence.
B=mod.	1.40±	Chrysocolla(?) $CuO.SiO_2.nH_2O$	Fib. *c*. Opal-like		Green	H=2± G=2	Decpd. by acid. Infus. Pleoc. faint: ω=nearly colorless, ϵ=pale bluish green.
	1.0 $_{red}$ 1.45$_{Na}$ 1.80$_{Tl}$	Covellite Cu_2S	Hex. Plates	{0001}perf	Indigo-blue, streak nearly black.	H=1.5 to 2 G=4.6	Sol. in HNO_3. F=2.5. Translucent only in thinnest plates. In transmitted light green and pleochroic.
1.57	1.46±	Chrysocolla(?) $CuO.SiO_2.2H_2O$	Fib. *c*. Opal-like		Beryl-blue	H=3 G=2.4	Decpd. by acid. Infus. Pleoc. faint: ω=colorless, ϵ=pale bluish green.
1.474	1.470	Gmelinite $(Na_2,Ca)O.Al_2O_3.4SiO_2.6H_2O$	Ps. trig. Cubic	$\{10\bar{1}0\}$dist	White	H=4.5 G=2.1	Zeolite group. Decpd. by HCl. F=3. 2V small to 0. Tw. axis *c*.
1.50	1.47	Hatchettite Hydrocarbon.	Orth(?)		do.	Very soft G=0.95	Sol. in alcohol and other organic liquids. F=very easy. Burns.
1.486	1.475	Laubanite $2CaO.Al_2O_3.5SiO_2.6H_2O$	Mon.(?) Fib. *c*.	Pris. good	do.	H=5 G=2.2	A zeolite. Decpd. by warm conct. HCl. Fuses to a blebby glass.
1.482	1.480	Chabazite $(Ca,Na_2)O.Al_2O_3.4SiO_2.6H_2O$	Ps. trig. Cubic	$\{10\bar{1}1\}$dist	do.	H=4.5 G=2.1	Zeolite group. Decpd. by HCl with separation of slimy silica. F=3, with intumescence. 2V small to 0.
B=weak.	1.48	Faujasite $Na_2O.CaO.2Al_2O_3.10SiO_2.20H_2O$	Oct.	{111}dist		H=5 G=1.92	Zeolite group. Decpd. by acid. F=3. Uniax. in eight segments from loss of H_2O.
1.500	1.488	Douglasite $2KCl.FeCl_2.2H_2O$	Mon(?)			G=2.16	Tend to lie on face normal to optic axes.
1.502	1.490	Hydronephelite $2Na_2O.3Al_2O_3.6SiO_2.7H_2O$	Hex. Fib		White	H=5 G=2.26	Zeolite group. Gelat. F=2 to 3.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial positive group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.499	1.491	Aphthitalite $(K,Na)_2O.SO_3$	Trig. Tab., rhombs.	$\{10\bar{1}0\}$rather dist., $\{0001\}$imperf.	White	H=3 G=2.69	Glaserite. Sol. in H_2O. F=1.5.
1.550	1.502	Paraffin Hydrocarbon.	Plates and fib.		do.	H=1 G=0.9	Insol. in acids. F=very easy. Burns. Lies on base on crushing below cover glass.
1.509	1.508	Leucite $K_2O.Al_2O_3.4SiO_2$	Ps. isomet. {211}	{110}poor	Colorless	H=6 G=2.5	Decpd. by acid. Infus. Inclusions characteristic. 2V small to 0. Poly. tw. lamellae.
1.54	1.515	Ozocerite Hydrocarbon.	Orth(?). Fib		White	H=1 G=0.9	Insol. in acids. F=very easy. Burns. Elongation of fibers is −. Lie on base.
1.522	1.518	Leifite $2Na_2O.(AlF)O.9SiO_2$	Hex. Pris.	Pris.	Colorless	H=6 G=2.57	Insol. in HCl. F=easy.
1.521	1.518	Davyne $4(Na,K)_2O.CaO.4Al_2O_3.9SiO_2.3H_2O.2CO_2$?	Hex.	$\{10\bar{1}0\}\{0001\}$perf.		H=5.5 G=2.4±	Compare with microsommite and cancrinite. Gelat. Fuses with intumescence.
1.529	1.521	Microsommite $3(Na,K)_2O.4CaO.6Al_2O_3.12SiO_2.SO_3.4(Na,K)Cl$	do.	$\{10\bar{1}0\}$ perf. $\{0001\}$ less so.	Colorless	H=6 G=2.4	Near cancrinite and davyne. Gelat. F=difficult.
1.527	1.522	Natrodavyne Near davyne but with no K and much CO_2.	do.	$\{10\bar{1}0\}\{0001\}$perf.	do.	H=6 G=2.50	Gelat. Fuses with intumescence.
1.575	1.533	Fibroferrite $Fe_2O_3.2SO_3.10H_2O$	Orth(?) Fib. c.		Pale yellow	H=2 G=1.86	Sol. in H_2O. F=4.5 to 5. Elongation+ Pleoc. feeble: ω=nearly colorless, ϵ= pale yellow.
1.537	1.535	Apophyllite $K_2O.8CaO.16SiO_2.16H_2O$	Tetrag.	{001}perf.{110}less so.	Colorless	H=5 G=2.3	A zeolite. Decpd. by HCl with separation of slimy silica. F=2. Opt. anom.
1.553	1.544	Quartz SiO_2	Trig. Hex. prisms and pyramids.	None	do.	H=7 G=2.66	Insol. in acid. Infus.
1.556	1.550	Coquimbite $Fe_2O_3.3SO_3.9H_2O$	Trig.	$\{10\bar{1}0\}\{10\bar{1}1\}\{01\bar{1}1\}$ imperf.	White, yellow, violet.	H=2 G=2.1	Sol. in H_2O. F=4.5 to 5. Tw. pl.(0001). Abnormal interference colors.

1.584	1.553	Narsarsukite Titanosilicate of Fe, Na, F, etc.	Tetrag. Oct.	{110} perf.	Honey-yellow to reddish or brownish gray.	H=7 G=2.75	Sol. in HF. F=easy. Pleoc. in thick section: ω=reddish-yellow, ε=colorless.
....	1.555	Soumansite Phosphate of Al and Na with H, O, and F.	do			H=4.5 G=2.87	F=difficult. Basal section divides into four biax. segments.
1.613	1.558	Ferrinatrite $3Na_2O.Fe_2O_3.6SO_3.6H_2O$	Trig. Acicular.	$\{10\bar{1}0\}$ perf. {1000} less so.	White, greenish, etc.	H=2 G=2.56±	Sol. in H_2O. F=1.5.
1.580	1.559	Brucite $MgO.H_2O$	Trig. Tabular.	{0001} eminent.	Colorless.	H=2.5 G=2.4	Flexible. Luster pearly on {0001}. Sol. in acids. Infus. Opt. anom.
B=weak	1.56	Colerainite $4MgO.Al_2O_3.2SiO_2.5H_2O$	Hex. Plates.		White.	H=2.5 to 3 G=2.51	Decpd. by HCl with difficulty. F=difficult.
1.580	1.560	Newtonite $Al_2O_3.2SiO_2.4H_2O$	Tetrag. Pyramids.		White. Chalky.	Soft G=2.37	Very minute crystals.
1.575	1.565	Pinnoite $MgO.B_2O_3.3H_2O$	Tetrag.		Sulphur-yellow.	H=3 to 4 G=2.29	Sol. in acid. F=3.
1.592	1.572	Alunite $K_2O.3Al_2O_3.4SO_3.6H_2O$	Trig. Tab. {0001} or cubic.	{0001} dist.	White.	H=4 G=2.60	Alunite group. Insol. in acid, but sol. in acid and partly in H_2O after ignition. Infus. but decrepitates.
1.579	1.576	Penninite $5(Mg,Fe)O.Al_2O_3.3SiO_2.4H_2O$	Mon. Hex. plates.	{001} perf.	Green, etc.	H=2 G=2.7	Chlorite group. Decpd. by H_2SO_4. F=5 to 5.5. (See Biaxial group, p. 213.) Abnormal blue interference color. Pleoc.: X and Y=green. Z=nearly colorless.
1.588	1.580	Coeruleolactite $3Al_2O_3.2P_2O_5.10H_2O$	Fib. Crusts.		Milk-white to light blue.	H=5 G=2.55 to 2.70	Sol. in acid. Infus.
1.645	1.582	Cacoxenite $2Fe_2O_3.P_2O_5.12H_2O$	Hex. Needles c.		Yellow.	H=3 to 4 G=3.38	Sol. in acid. F=2.5 to 3. Pleoc. considerable: ω=pale yellowish, ε=orange yellow to canary yellow. Abs.: ε>ω.
1.602	1.583	Alumian $Al_2O_3.2SO_3$	Trig. Rhombs resembling cubes.	Traces.	White.	H=2 to 3 G=2.74±	Sol. in acid. Infus.
B=0.01	1.585±	Natroalunite $Na_2O.3Al_2O_3.4SO_3.6H_2O$	Trig. Tab. {0001} or cubic.	{0001} dist.	White, etc.	H=4 G=2.6	Alunite group. Sol. in acid and partly in H_2O only after ignition. Infus. but decrepitates.
B=low	1.587	Rumpfite $7MgO.8Al_2O_3.10SiO_2.14H_2O$	Mon. Scales.	{001} perf.	Greenish gray.	H=1.5 G=2.67	Chlorite group. Slowly sol. in acid. F=4. 2E=0 to 10°.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial positive group—Continued.

ε	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.590	1.589	Rinneite $FeCl_2.3KCl.NaCl$	Trig	$\{10\bar{1}0\}\{11\bar{2}0\}$ fair	Colorless, rose, yellow.	H=3 G=2.35	Sol. in acid. F=easy.
B=very weak.	1.59	Chlormanganokalite $4KCl.MnCl_2$	do	None	Yellow	H=2.5 G=2.31	Deliquescent. Readily fus.
1.612	1.597	Amesite $2(Mg,Fe)O.Al_2O_3.SiO_2.2H_2O$	Ps. hex. Plates	{001} mic	Pale bluish green	H=2 to 3 G=2.77	Chlorite group. Decpd. by HCl. Infus but swells on heating. MgO : FeO=5 : 1.
1.615	1.604	Sarcolite $3CaO.Al_2O_3.3SiO_2$	Tetrag. Cubo-oct.		Rose	H=6 G=2.4 to 2.9	Melilite group. Gelat. F=3. Anom. biax.
1.611	1.606	Eudialyte $6Na_2O.6(Ca,Fe)O.20(Si,Zr)O_2.NaCl$	Hex	{0001} dist. $\{10\bar{2}0\}$ poor.	Pale pink	H=5 G=3.0	Gelat. F=3. Opt. anom. Pleoc. weak. Abs.: ω>ε.
B=0.02	1.615	Fluocerite $(Ce,La,Di)F_3$	do	{0001} perf.	Reddish yellow	H=4 G=5.8±	Sol. in acid. Infus.
1.654	1.620	Churchite $3CaO.5Ce_2O_3.6P_2O_5.24H_2O$	Rectangular tablets beveled parallel to the long edge.	{001} perf.	Smoky gray tinged with red.	H=3 G=3.14	Sol. in acid. Infus. Z (or ε) is normal to the tablets.
B=weak	1.625	Georceixite $(Ba,Ca,Ce)O.2Al_2O_3.P_2O_5.5H_2O$	Trig.? Microcryst.		Brown, white, etc.	H=6 G=3.10	Alunite group.
1.630 1.639	1.620 1.629	Goyazite $2SrO.3Al_2O_3.2P_2O_5.7H_2O$	Trig. Tab. {0001}	{0001} perf.	Colorless, etc.	H=5 G=3.20 to 3.26	Alunite group. Insol. in acids. F=4. Zonal growths. Basal segments commonly show anom. B. in hexagonal segments. Pleoc.: ω=red-brown, ε=yellow.
1.639	1.633	Åkermanite $4MgO.8CaO.9SiO_2$	Tetrag	{001}, {110}	do	H=5 G=3.12	Melilite group. Gelat. Data for pure mineral.
B=0.01	1.64	Svanbergite $2SrO.3Al_2O_3.P_2O_5.2SO_3.6H_2O$	Trig. Cubic	{0001} perf.	Colorless	H=5 G=3.52	Alunite group. Difficultly fus. Nearly insol. Basal section divides into six biax. segments.

1.702	1.644	Plancheite $6CuO.5SiO_2.2H_2O$	Mon.? Fib.		Blue	H=5.5 G=3.36	Difficultly sol. in acids. Pleoc. in blue tints. Abs.: Z>X. Compare dioptase.
1.697	1.644	Dioptase $CuO.SiO_2.H_2O$	Trig.	{10$\bar{1}$1}perf.	Emerald-green	H=5 G=3.05	Gelat. Infus. Anom. biax. Abs. in thick section: $\omega>\epsilon$.
B=.01	1.65	Auerlite Silico-phosphate of Th, etc.	Tetrag.		Yellow	H=3 G=4.06	Infus.
1.670	1.654	Phenacite $2GlO.SiO_2$	Trig. Pris.	{11$\bar{2}$0}dist.	Colorless, yellow, rose, brown.	H=7.5 G=3.0	Insol. in acid. Infus. Tw. pl. {10$\bar{1}$0} penet. Pleoc. faint.
1.676	1.654	Plumbogummite $2PbO.3Al_2O_3.2P_2O_5.7H_2O$	Hex. Gumlike.		Yellow, brown	H=4 to 5 G=4.0 to 4.9	Sol. in HNO_3. F=2(?).
1.703	1.654	Rhabdophanite $(Y, Er, La, Di)_2O_3.P_2O_5.2H_2O$	Fib.		Brown, reddish, yellowish, white.	H=3.5 G=4.0	Sol. in acid. Infus.
1.757	1.676±	Parisite $2(Ce, La, Di, Th)OF.CaO.3CO_2$	Trig.	None. {0001} perf. on alteration.	Yellow	H=4.5 G=4.32	Sol. in acid. Infus. Pleoc.: ω=light-yellow, ϵ=golden-yellow.
1.685	1.680±	Florencite $3Al_2O_3.Ce_2O_3.2P_2O_5.6H_2O$	do.	{0001}rather perf.	Brown, etc.	H=5 G=3.59	Alunite group. Partly sol. in HCl. Infus.
1.723	1.694	Willemite $2ZnO.SiO_2$	do.	{0001}variable, {11$\bar{2}$0}variable.	White, green, red, brown, etc.	H=5.5 G=3.9±	Gelat. Infus.
1.721	1.716	Vesuvianite $2(Ca, Mn, Mg, Fe)O.(Al, Fe)(OH, F)O.2SiO_2$	Tetrag. Pris.	{110}poor	Variable	H=6.5 G=3.4	Insol. in acid. F=3. Pleoc. weak: $\omega>\epsilon$. Opt. anom.
1.818	1.717	Bastnaesite $(Ce, La, Di)FO.CO_2$	Hex. Pris.	{0001}parting	Yellow, reddish, brown.	H=4 G=5.0	Difficultly sol. in acid. Infus. Nearly colorless in powder. Feebly pleoc.
1.816	1.721	Xenotime $Y_2O_3.P_2O_5$	Tetrag.	{110}perf.	Yellow-brown, red-brown, gray.	H=4 to 5 G=4.59	Insol. in HCl. Infus. Pleoc. weak: ω= pink or light yellowish brown, ϵ= brownish yellow or greenish.
1.746	1.724	Connellite $20CuO.SO_3.2CuCl_2.20H_2O$	Hex. Acic.		Fine blue, greenish blue.	H=3 G=3.40	Sol. in HCl. F=2.5.
1.810	1.730	Mixite $20CuO.Bi_2O_3.5As_2O_5.22H_2O$	Acic.		Emerald-green, blue-green.	H=3 to 4 G=3.79	F=2. In section pale green and nonpleochroic.
1.82	1.755	Vegasite $PbO.2Fe_2O_3.3SO_3.4H_2O$?	Hex. Minute plates.				
1.804	1.757	Benitoite $BaO.TiO_2.3SiO_2$	Hex. Pyram. or tab.	{10$\bar{1}$1}imperf.	Blue	H=6 G=3.65	Sol. in HF. F=3. Pleoc.: ω=colorless, ϵ=purple-blue, etc.
1.801	1.778	Conichalcite $4(Cu, Ca)O.As_2O_5.1\frac{1}{2}H_2O$	Fib.		Pistachio-green to emerald-green.	H=4.5 G=4.13	F=3. In section pale green and nonpleochroic.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial positive group—Continued.

ε	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.803	1.794	Arseniopleite $9(Mn,Ca,Pb,Mg)O.(Mn,Fe)_2O_3.3As_2O_5.3H_2O$	Trig.		Brownish red		In section apricot orange and nonpleochroic.
	High.	Thorite $ThO_2.SiO_2$	Tetrag. Sq. pyramids.	{110}dist.	Black, reddish-brown, orange.	H=5 G=5.3	Gelat. before calcination? Infus. Commonly isot. from alteration.
B=0.04±	1.865±	Ancylite $2Ce_2O_3.3SrO.7CO_2.5H_2O$	Ps. orth. Rhombic pyramids.		Hair-brown, yellow-green, orange.	H=4.5 G=3.95	Related to bastnaesite. Sol. in acid. Infus.
2.12	1.90	Trippkeite Arsenate of Cu.	Tetrag. Oct.	{100} highly perf. {110} less perf.	Bluish green	Soft	Easily sol. in acid. F=easy. Crystals break up into flexible, asbestos-like pieces. Bluish-green in section and nonpleochroic.
1.945	1.910	Ganomalite $6PbO.4(Ca,Mn)O.6SiO_2.H_2O$	Hex. Tab.{0001}	{0001},{10$\bar{1}$0} perf.	Gray	H=3 G=5.74	Gelat. F=3? Anom. biax. B is variable.
1.923	1.913	Nasonite $5PbO.4CaO.PbCl_2.6SiO_2$	Hex. Pris.	{0001}, {10$\bar{1}$0} imperf.	White	H=4 G=5.43	F=easy.
1.934	1.918	Scheelite $CaO.WO_3$	Tetrag. Oct. or tab.	{111} dist.	White, yellow, brown, gray.	H=5 G=6.12	Decpd. by HCl. F=5. Tw. pl. {100}. G=6.12 for pure mineral, but decreases to 5.94 for mineral with 8 per cent MoO_3. Gives a deep-blue color when powder is boiled with HCl. and again boiled after zinc or tin is added.
1.968 2.015	1.923 1.960	Zircon $ZrO_2.SiO_2$.	Tetrag. Short prisms and pyramids.	{110} rare.	Colorless. Yellow, brown, gray, pink, etc.	H=7.5 G=4.5±	Insol. in acid. Infus. Anom. 2E.
1.971	1.945	Nasonite $5PbO.4CaO.PbCl_2.6SiO_2$	Hex. Pris.	{0001}, {10$\bar{1}$0} imperf.	White	H=3 G=5.43	F=easy.
	1.96	Dixenite $5MnO.SiO_2.As_2O_3.H_2O$	Hex. Plates	{0001} mic.	Black	H=3-4 G=4.20	Decpd. in HCl. Glowing red in transmitted light.
1.978	1.967	Powellite $CaO.(Mo,W)O_3$	Tetrag. Pyramids	None	Pale greenish yellow.	H=3.5 G=4.35 to 4.53	Decpd. by acid. F=4.

2.656_{Na} 2.601_{Li}	1.973_{Na}	Calomel Hg_2Cl_2	Tetrag.	{100} {111} rather dist.	Colorless	H=1 to 2 G=6.48	Sectile. Insol. in H_2O. Volatilizes at 1.
2.093	1.997	Cassiterite SnO_2	do.	{100} {111} imperf.	Brown, black, gray, white.	H=6 to 7 G=6.8 to 7.1	Insol. in acid. Infus. Tw. {110} polysynthetic. Anom. 2E. Becomes coated with metallic tin when embedded in granulated zinc and HCl.
2.029	2.008	Zincite ZnO	Hex.	{0001} perf.	Deep red.	H=4 G=5.68	Sol. in acid. Infus. Streak orange-yellow. Section deep red, nonpleochroic.
B=rather strong.	2.03±	Voltzite ZnO.4ZnS	Hex. Spherical globules.		Yellowish, reddish, brownish.	H=4 G=3.7	Decpd. by acids. Infus.
2.140	2.114	Phosgenite $PbO.PbCl_2.CO_2$	Tetrag. Pris. tab.	{110} {100} dist.	White, gray, yellow.	H=3 G=6.0 to 6.3	Sol. in dil. HNO_3, with effervescence. F=1.
2.21	2.13	Penfieldite $PbO.2PbCl_2$	Hex. Prisms.	{0001} dist.	White.		Sol. in HNO_3. F=1.
B=0.01	2.182	Iodyrite AgI	Hex. Thin plates.	{0001} perf.	Yellowish, greenish, brownish.	H=1 to 1.5 G=5.6	Sectile. Sol. in NH_4OH. F=1. Becomes isotropic at 146° C. Abnormal green interference colors.
2.21	2.19	Kleinite Hg, NH_4, Cl, SO_4, etc.	Hex. Short prisms.	{0001} good.	Yellow, orange.	H=3.5 G=7.98	Sol. in acid. Biax.— at ordinary temperature.
2.22	2.21	Iodyrite AgI	Hex. Thin plates.	{0001} perf.	Yellowish, greenish, brownish.	H=1 to 1.5 G=5.6	Sectile. Sol. in NH_4OH. Fuses. Isotropic at 146° C. Abnormal green interference colors. Anom. 2V small.
2.42_{Li}	2.27_{Li}	Tapiolite $FeO.(Ta,Cb)_2O_5$	Tetrag. Oct.		Black.	H=6 G=7.3 to 7.8	Infus. Red brown in section. Pleoc. very strong: ω=pale yellowish or reddish brown, ε=nearly opaque. Indices for mineral with G=7.4.
2.4_{Li}	2.30_{Li}	Hielmite Stannotantalate and columbate of Y, Fe, Mn, Ce, etc.	Ps. orth.		do.	H=5 G=5.82	Infus. Pleoc. very strong: ω=yellowish brown, ε=nearly opaque.
2.378_{Na} 2.35_{Li}	2.356_{Na} 2.33_{Li}	Wurtzite ZnS	Hex. Short prisms. Lamellar {0001}.	$11\bar{2}0$ easy, {0001} difficult.	Varies.	H=4 G=3.98	Sol. in acids. F=very dif. Feebly pleoc.
2.51_{Li}	2.45_{Li}	Derbylite $6FeO.Sb_2O_3.5TiO_2$	Orth. Pris. c.		Black.	H=5 G=4.53	Insol. in acid. Infus. Nearly opaque. Nonpleochroic. See Biax.
B=mod.	2.50_{Li}	Strueverite $FeO.(Ta,Cb)_2O_5.4TiO_2$	Tetrag.		Iron-black.	H=6 G=5.56	Pleoc. very strong: ω=brown, ε=green and nearly opaque. May be opt. —.
2.529_{Na} 2.456_{Li}	2.506_{Na} 2.431_{Li}	Greenockite CdS	Hex. Short prisms. Crusts.	$\{11\bar{2}0\}$ dist., {0001} indist.	Varies.	H=3 to 3.5 G=5.0	Sol. in HCl. Infus. Data for pure artificial crystals.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial positive group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.903	2.616	Rutile TiO_2	Tetrag. Pris.	{100}{110} dist.	Yellow, red, brown, etc.	H=6 G=4.24	Insol. in acid. Infus. Pleoc. faint.
2.673_{Li} 2.697_{Na} 2.721_{Tl}	2.633_{Li} 2.654_{Na} 2.675_{Tl}	Moissanite CSi	Hex. Plates {0001}		Green to black	H=9.5 G=3.1	Insol. in acid. Infus. Pleoc.: ω=light blue, ϵ=deep indigo blue. Data for artificial product.
3.201 3.146_{Li}	2.854 2.819_{Li}	Cinnabar HgS	Hex	{10$\bar{1}$0} perf.	Cochineal-red	H=2 G=8.1	Volatizes at 1.5. Disp. very great. Circular polarization. Streak scarlet.

Uniaxial negative group.

[The greater part of the minerals of this group are tetragonal or hexagonal, but some minerals that are strictly biaxial, though their axial angle is nearly zero, are included here as well as in their proper biaxial group. Many of these biaxial minerals which have nearly uniaxial optical properties have also nearly hexagonal crystal form.]

B=very weak	1.328	Villiaumite NaF	Tetrag. Ps. isomet.	{001}perf. {100}, {010}dist.	Carmine-red, etc.	H=3.5 G=2.79	Sol. in H_2O. Pleoc.: ω=carmine-red, ϵ=golden-yellow.
1.342	1.349	Chiolite $2NaF.AlF_3$	Tetrag. Sq. prisms.	{001}perf. {111} good.	White	H=3.5 *to* 4 G=3.00	Sol. in acid. F=1.5.
1.432	1.458	Mendozite $Na_2O.Al_2O_3.4SO_3.24H_2O$	Fibers		do.	H=3 G=1.73	Sol. in H_2O. F=1. May be biax.
1.464	1.465	Gmelinite $(Na_2,Ca)O.Al_2O_3.4SiO_2.6H_2O$	Trig.	{10$\bar{1}$0}easy	Colorless	H=4.5 G=2.1	Zeolite group. Decpd. by acid. F=3. Opt. anom. 2V=small. Tw. axis *c*.
1.478	1.480	Chabazite $(Ca,Na_2)O.Al_2O_3.4SiO_2.6H_2O$	Trig. Cubic habit.	{10$\bar{1}$1}dist.	White	H=4.5 G=2.1	Do.
1.461	1.481	Hanksite $11Na_2O.9SO_3.2CO_2.KCl$	Hex. Short prisms.	{0001}dist.	do.	H=3 G=2.56	Readily sol. in H_2O. F=1.5.
1.484	1.487	Cristobalite SiO_2	Tetrag.? Ps. isomet. Oct.		Colorless	H=6 to 7 G=2.3	Insol. in acid. Infus. May be biax.
1.486	1.487	Analcite $Na_2O.Al_2O_3.4SiO_2.2H_2O$	Ps. isomet. {211}	Cubic tr.	do.	H=5 G=2.25	Zeolite group. Decpd. by acid. F=3.5. Often biax.

B=.01	1.49	Ettringite $6CaO.Al_2O_3.3SO_3.33H_2O$	Hex. Acic. c	{10$\bar{1}$0}perf	White	H=2 to 2.5 G=1.75	Sol. in HCl. F=3.
1.471	1.490	Loeweite $MgO.Na_2O.2SO_3.2\frac{1}{2}H_2O$	Trig	{0001}dist	do	H=3.5 G=2.37	Sol. in H_2O. F=1.5. Opt. anom.
1.491	1.496	Levynite $CaO.Al_2O_3.3SiO_2.5H_2O$	do	{02$\bar{2}$1}dist	do	H=4 G=2.1	Zeolite group. Gelat. F=2 to 2.5.
1.468	1.507	Thaumasite $3CaO.CO_2.SO_3.SiO_2.15H_2O$	Hex. Fib., etc	Tr	do	H=3.5 G=1.87	Decpd. by acids. Infus.
1.500	1.507	Sulphatic cancrinite $4Na_2O.CaO.4Al_2O_3.CO_2.SO_3.9SiO_2.3H_2O$	Hex	{10$\bar{1}$0}perf	Colorless	H=5 G=2.44	Gelat. F=2. Data for mineral with percentages of CO_2=3.13, SO_3=4.65.
1.486	1.509	Nocerite $2(Ca,Mg)F_2.(Ca,Mg)O$	Hex. Acic		White	G=2.96	
1.498	1.512	Hydrotalcite $6MgO.Al_2O_3.CO_2.12H_2O$	Hex. Plates	{0001}mic	White. Pearly luster.	H=2 G=2.06	Hydrotalcite group. Sol. in acids. Infus.
1.470	1.516±	Leverrierite $Al_2O_3.3\pm SiO_2.3\pm H_2O$	Basal plates	{001}mic	White, green, yellow, brown.	H=1.5 G=2.6	Infus. On standing in oils ω increases to 1.60. Becomes plastic in water. Loses its H_2O below 200°C.
1.513	1.522	Tachhydrite $CaCl_2.2MgCl_2.12H_2O$	Trig	{10$\bar{1}$1}good	Wax to honey-yellow.	Soft G=1.67(?)	Very deliquescent. F=1.
1.496	1.524	Cancrinite $4Na_2O.CaO.4Al_2O_3.2CO_2.9SiO_2.3H_2O$	Hex	{10$\bar{1}$0}perf	Colorless, gray, yellow.	H=5 to 6 G=2.45	Gelat. F=2.
1.529	1.532	Milarite $K_2O.4CaO.2Al_2O_3.24SiO_2.H_2O$	Ps. hex		Pale green	H=5.5 to 6 G=2.57	Insol. in acid. F=3. Basal section shows six biax. segments. Uniax. at a high temp.
1.514	1.534	Zincaluminite $6ZnO.3Al_2O_3.2SO_3.18H_2O$	Hex. Plates		White	H=2.5 to 3 G=2.26	Sol. in acid. Infus.
1.533	1.537	Kaliophilite $K_2O.Al_2O_3.2SiO_2$	Hex. Prisms	{10$\bar{1}$0}dist	Colorless	H=6 G=2.49 2.60	Nepheline group. Gelat. F=3.5.
1.535	1.537	Apophyllite $K_2O.8CaO.16SiO_2.16H_2O$	Tetrag	{001} highly perf. {110}less so.	Colorless, rose, etc.	H=5 G=2.35	Zeolite group. Decpd. by acid. Fus. 1.5. Opt. anom.
1.511	1.539	Mellite $Al_2O_3.C_{12}O_9.18H_2O$	Tetrag. Sq. pyramids.	{111}indist	Honey-yellow, red-brown, white.	H=2.5 G=1.6	Sol. in HNO_3. Decpd. by boiling H_2O. 2E reaches 8°.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.537	1.539	Marialite $3Na_2O.3Al_2O_3.18SiO_2.2NaCl$	Tetrag	{100}perf. {110} less so.	Colorless, etc	H=6 G=2.56	Scapolite $Ma_{100}Me_0$, low in CO_2. Insol. in acid. F=3 to 4. Cl_2 may be replaced by CO_3 and SO_4. CO_2 increases the birefringence.
1.510	1.540	Brugnatellite $6MgO.Fe_2O_3.CO_2.12H_2O$	Hex. Tab.{0001}.	{0001}mic	White, etc. Pearly luster	H=2 to 3 G=2.07	Near pyroaurite. Hydrotalcite group, Sol. in acids. Infus. Pleoc.: ω=yellow red, ϵ=colorless.
1.538	1.542	Nephelite $Na_2O.Al_2O_3.2SiO_2$	Hex	{10$\bar{1}$0}dist. {0001} *imperf.*	Colorless	H=6 G=2.6	Nepheline group. Gelat. F=3.5. Luster greasy.
1.516	1.542	Stichtite $6MgO.Cr_2O_3.CO_2.12H_2O$	Hex. Plates{0001}	{0001}mic	Green	H=1.75 G=2.16	Hydrotalcite group. Sol. in acid. Infus. Anom. biax. Pleoc. weak. Abs.: $\omega > \epsilon$.
B=low.	1.545	Eucryptite $Li_2O.Al_2O_3.2SiO_2$	Hex	{0001}dist		G=2.67	Nepheline group. Gelat.
1.503	1.545	Pholidolite $K_2O.12(Mg,Fe)O.Al_2O_3.13SiO_2.5H_2O$	Mon. Hex. scales.	{001}mic	Grayish yellow	H=4 G=2.41	Nearly colorless in section. Biax. with 2V small.
B=0.01	1.545	Gyrolite $4CaO.6SiO_2.5(H,Na,K)_2O$	*Trig. Fib. lamellae.*	*{0001}mic*	White, etc	H=3 to 4 G=2.43	Zeolite group. Decpd. by HCl. F=difficult.
1.538	1.551	Mizzonite Scapolite.	Tetrag	{100}rather perf. {110}less so.	Colorless, etc	H=6 G=2.61	Scapolite group. Data for $Ma_{75}Me_{25}$, low in CO_2. Insol. in acid. F=3. CO_2 increases the birefringence.
B=0.01	1.555	Saponite MgO, Al_2O_3,SiO_2,H_2O	Minute scales		Greasy white	Soft G=2.26±	
1.54	1.560	Jefferisite $5(Mg,Fe)O.2(Al, Fe)_2O_3.5SiO_2.$ *$11H_2O$(?)*	Ps. hex	{0001}mic	White, green, brown, etc.	H=1.5 G=2.30	A vermiculite. Altered mica. Decpd. by HCl. When heated at 300° C. it exfoliates very remarkably; on higher heating it becomes pearly white and ultimately fuses to a dark-gray mass.
1.560	1.565	Zeophyllite $3CaO.CaF_2.3SiO_2.2H_2O$	Trig	do	Colorless, white	H=3 G=2.76	Zeolite group. Gelat. F=very easy. Biaxial borders. 2V=0 to 27½° and disp. $\rho < \upsilon$.

B=0.01	1.565±	Pyroaurite $6MgO.Fe_2O_3.CO_2.12H_2O$	Hex. Tab.{0001} Fib.	{0001}mic	White, etc. Pearly.	H=2 to 3 G=2.07	Hydrotalcite group. Sol. in acid. Infus. Pleoc.: ω=yellow red, ε=colorless.
1.564	1.568	Beryl $3GlO.Al_2O_3.6SiO_2$	Hex. Pris.	{0001}imperf.	Colorless, green, blue, etc.	H=8 G=2.66	Insol. in acid. Infus. Pleoc. variable. Data for mineral with $Na_2O=0.43$.
1.545	1.567	Wernerite Scapolite.	Tetrag.	{100}rather perf. {110}less so.	Colorless, etc.	H=5 to 6 G=2.65	Scapolite group. Data for $Ma_{50}Me_{50}$, low in carbonate. Insol. in acid. F=3. The carbonate scapolite has a stronger birefringence.
B=weak	1.57	Lawrencite $FeCl_2$	Hex. Tablets		Green or brown		Not stable.
1.57	1.575	Calcioferrite $6CaO.3Fe_2O_3.4P_2O_5.19H_2O$	Mon.? Scales, nodules.	{001}very perf.	Yellow-green	H=2.5 G=2.53	Easily decpd. by HCl. F=easy.
1.577	1.579	Penninite $5(Mg,Fe)O.Al_2O_3.3SiO_2.4H_2O$	Mon. Hex. plates and shreds.	{001}perf.	Green, etc.	H=2 G=2.7	Chlorite group. Decpd. by H_2SO_4. F=dif. Biax. with 2V=0±. Pleoc.: X nearly colorless, Y and Z green. Abnormal blue interference color.
1.575	1.581	Beryl $3GlO.Al_2O_3.6SiO_2$	Hex. Pris.	{001}imperf.	Colorless, green, blue, yellow.	H=8 G=2.714	Insol. in acid. Infus. Pleoc. variable. Data for mineral low in alkalies.
1.551	1.582	Wernerite Scapolite.	Tetrag.	{100}perf.	Colorless, grayish, bluish, reddish.	H=6 G=2.69	Scapolite. Data for $Ma_{25}Me_{75}$, low in carbonate. Decpd. by acid. F=3.
1.560	1.586	Uranospinite $CaO.2UO_3.As_2O_5.8H_2O$	Tetrag. Ps. orth. Rect. tablets.	{001}	Yellow	H=2 to 3 G=3.45	Sol. in acid. Fus. See biax.—. Pleoc.: ω=pale yellow, ε=colorless.
1.336	1.587	Soda niter $Na_2O.N_2O_5$	Trig.	{10$\bar{1}$1}perf.	White	H=2 G=2.27	Tastes cooling. Soluble in H_2O. F=1. Deflagrates on heating.
1.573	1.591	Metavoltaite $5(K_2,Na_2,Fe)O.3Fe_2O_3.12SO_3.18H_2O$	Hex. Scales		Yellow	H=2.5 G=2.53	Sol. in acid. Partly sol. in H_2O. F=5. Pleoc.: ω=yellow, ε=green to nearly colorless.
1.56	1.59±	Connarite $2NiO_2.3SiO_2.2H_2O$	Hex.	{0001}perf.	Yellow-green	H=2.5 to 3 G=2.5	Faintly pleoc.
1.582	1.592	Torbernite $CuO.2UO_3.P_2O_5.8?H_2O$	Tetrag. or Mon. Tab. {001}.	{001}mic.	Green, yellow, red.	H=2 G=3.5	Luster on (0001) pearly. Sol. in H_2SO_4. F=3.
1.585	1.595	Crandallite $CaO.2Al_2O_3.P_2O_5.5H_2O$	Fib.		White	H=4	Pseudomorph after goyazite. Sol. in acid. B. b. decrepitates and fuses.
1.560	1.597	Meionite $4CaO.3Al_2O_3.6SiO_2.(CO_2,SO_3)$	Tetrag.	{100}perf.{110}less so.	Colorless	H=5.5 G=2.74	Scapolite. Data for Ma_0Me_{100}. Decpd. by acid. F=4.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ε	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.590	1.598	Beryl $3(Gl,Na_2)O.Al_2O_3.6SiO_2$	Hex. Prisms	{0001}imperf	Colorless, etc	H=6 G=2.80	Insol. in acid. Infus. Pleoc. variable. Data on mineral high in alkalies.
B=strong	1.600	Biotite $K_2O.4(Mg,Fe)O.2(Al,Fe)_2O_3.6SiO_2.H_2O$	Mon. Hex. plates.	{001}mic	Brown, black, green	H=3 G=2.7 to 3.1	Mica group. Decpd. by H_2SO_4. Difficultly fus. Pleoc. marked in brown or green. Abs.: X<Y and Z.
1.555	1.600	Leverrierite $Al_2O_3.3\pm SiO_2.3\pm H_2O$	Basal plates	do	White, green, yellow, brown.	H=1.5 G=2.6	Infus. Data for grains after standing in oil for some time. (See p. 193.)
1.593	1.612	Meliphanite $2CaO.2GlO.3SiO_2.NaF$	Tetrag. Obtuse pyramids.	{001}dist	Yellow	H=5 G=3.01	Insol. Fuses with intumescence. Anom. biax.
1.607	1.613	Fluocerite $(Ce,La,Di)F_3$	Hex	{0001}perf	Wax-yellow	H=4.5 to 5 G=5.6 to 6.1	Insol. in acid. Infus.
1.609	1.620±	Dahllite $7CaO.2P_2O_5.CO_2.\frac{1}{2}H_2O$	Hex. Fib		Colorless, etc	H=5 G=2.87 to 3.05	Apatite group. Sol. in acid. Infus.
1.619	1.621	Gillespite $BaO.FeO.4SiO_2$		Basal mic	Rose-red	H=3 G=3.33	Decpd. by HCl. F=very easy. Pleoc. strong: ω=very pale pink, ε=deep rose red.
1.618	1.621	Eucolite $6Na_2O.6(Ca,Fe)O.20(Si,Zr)O_2.NaCl$	Trig	{0001}imperf.{11$\bar{2}$0} poor.	Colorless, brown, red, etc.	H=5 G=3.1	Gelat. F=2.5.
B=low.	1.625	Francolite $10CaO.3P_2O_5.CO_2.CaF_2.H_2O$	Ps. hex. Fib			H=4.5 G=3.1	Apatite group. Sol. in HNO_3 or NH_4OH. F=easy. Basal section shows six biax. segments.
1.605±	1.626	Bazzite Silicate of Sc, etc.	Hex. Barrel shapes		Bright azure blue.	H=6.5 G=2.8	Insol. in acids. Infus. but becomes dark and opaque b. b. Pleoc.: ω=very pale greenish yellow, ε=intense azure blue.
1.582	1.627	Troegerite $3UO_3.As_2O_5.12H_2O$	Tetrag.? Sq. tablets{001}.	{100}perf., {100} good.	Lemon-yellow	Soft G=3.3	Sol. in acid. F=2.5.
1.613	1.632	Dravite $Na_2O,(Mg,Fe)O,Al_2O_3,SiO_2,B_2O_3,H_2O$	Hex. Pris	None	Brown to black	H=7 G=3.1	Magnesian tourmaline. Insol. in acid. Fus. Pleoc. Abs.: ω>ε.

1.602	1.632	Bementite $4MnO.3SiO_2.3H_2O$	Stalactitic. Fib.		Brown	H=3 to 3.5 G=2.90	Tend to lie on basc. Weakly pleoc.: $\omega>\epsilon$.
1.575	1.632	Chalcophyllite $7CuO.As_2O_5.14H_2O$	Trig. Hex. tablets.	{0001}highly perf. {10$\bar{1}$1}traces.	Emerald-green	H=2 G=2.5	Luster on {0001} pearly. Related to tyrolite. Sol. in HNO_3 and NH_4OH. F=2 to 2.5.
1.626	1.632	Melilite $Na_2O, CaO, MgO, Fe_2O_3, Al_2O_3, SiO_2$	Tetrag	{001}dist	Colorless, etc	H=5 G=2.98	Melilite group. Gelat. F=3. Data for mineral with percentages of åkermanite=41.3, sarcolite and soda sarcolite=58.7.
1.629	1.633	Voelckerite $10CaO.3P_2O_5$	Hex	None	White		Apatite group. Sol. in HCl. Infus.
1.629	1.633	Melilite $Na_2O, CaO, MgO, Fe_2O_3, Al_2O_3, SiO_2$	Tetrag. Massive, etc.	{001}dist	Colorless, etc	H=5 G=2.93	Melilite group. Gelat. F=3. Pleoc. rare: ω=light yellow, ϵ=dark yellow. Data for mineral with percentages of åkermanite=48.5, sarcolite=27.5, soda sarcolite=9.0, velardenite=15.
1.631	1.634	Apatite $9CaO.3P_2O_5.Ca(F,Cl)_2$	Hex. Pris.	{0001}imperf.	Colorless	H=5 G=3.2	Apatite group. ω increases with Cl. Sol. in acid. F=5. Pleoc. rare. Abs.: $\epsilon>\omega$.
1.631	1.635	Dahllite $7CaO.2P_2O_5.CO_2$	Hex. Fib	None		H=3 G=3.08	Apatite group. Sol. in HCl. Infus. Optical anom. in hex. segments.
B=0.05	1.64	Lepidomelane Iron-rich biotite.	Mon. Scales	{001}mic	Black	H=3 G=3.1±	Mica group. Gelat. F=4.5 to 5. Green etc., in section and strongly pleoc. Abs.: $\omega>\epsilon$.
B=mod.?	1.640	Jeremejevite $Al_2O_3.B_2O_3$	Ps. hex. Pris	None	Colorless	H=6.5 G=3.28	Resembles beryl. Sol. in KOH. Infus. Divides into six sectors. 2E variable.
1.623	1.643	Zeunerite $CuO.2UO_3.As_2O_5.8H_2O$	Tetrag. Cubic, tab. {001}.	{001}perf	Grass, apple, or emerald green.	H=2 to 2.5 G=3.2	Sol. in HNO_3. F=3. Pale green in section.
1.629	1.647	Elbaite $SiO_2, B_2O_3, Al_2O_3, Li_2O, H_2O$	Hex. Pris	None	Colorless to pale red, green, etc.	H=7 G=3.02	Lithia tourmaline. Insol. in acid. F=dif.
1.643	1.649	Daphnite $27FeO.10Al_2O_3.18SiO_2.28H_2O$	Mon. Plates and fib.	{001}perf	Dark green	Soft	Chlorite group. Decpd. by warm HCl. Pleoc.: ω=olive-green, ϵ=pale yellowish.
1.624	1.650	Bementite $5MnO.4SiO_2.3H_2O$	Orth. Plates {100}, fibers.	{100} mic., {010}, {001} perf.	Pale yellow. Pearly.	H=6 G=3.11	Decpd. by acid. F=3.5.
1.59	1.65	Szaibelyite $10MgO.4B_2O_3.3H_2O$	Acic. Nodular		White, yellow	H=3 to 4 G=3	Sol. in acid. Fus.
1.650	1.655	Wilkeite $19CaO.3P_2O_5.CO_2.3SiO_2.3SO_3$	Hex. Pris	None	Pale, rose-red, etc.	H=5 G=3.23	Apatite group. Sol. in acid. F=5½.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.486	1.658	Calcite $CaO.CO_2$	Trig.	{$10\bar{1}1$}perf.	Colorless, etc.	H=3 G=2.715	Effervesces in acid. Infus. Data on pure $CaCO_3$.
B=weak	1.660	Fermorite $9(Ca,Sr)O.(P,As)_2O_5.Ca(OH,F)_2$	Hex.	None.		H=5 G=3.52	Apatite group. Luster greasy. Sol. in acids. Infus.
1.629	1.664	Friedelite $9(Mn,Fe)O.8SiO_2.MnCl_2.7H_2O$	Trig. Tab. {0001}.	{0001}perf. {$10\bar{1}0$} imperf.	Colorless, pink	H=4 G=3.07	Decpd. in acid. F=4 to a black glass. Nearly colorless in section. Thick plates pleoc. Abs.: $\omega>\epsilon$. Opt. anom. with small 2V and optic plane {$11\bar{2}0$}.
1.661	1.666	Gehlenite CaO,MgO,Al_2O_3,SiO_2	Tetrag.	{001}imperf.	Colorless, etc.	H=5.5 G=3.04	Melilite group. Gelat. F=6. Data for mineral with percentages of åkermanite=20, velardenite=80.
1.658	1.669	Velardenite $2CaO.Al_2O_3.SiO_2$	Tetrag. Rect.	{001}imperf.	Colorless	H=6 G=3.04	Melilite group. Gelat. F=6. Data for pure artificial mineral.
1.638	1.669	Schorlite Na_2O, (Fe, Mg)O, Al_2O_3, SiO_2, B_2O_3, H_2O, etc.	Hex. Pris.	None.	Black	H=7 G=3.22	Iron tourmaline. Insol. F=dif. Abs.: $\omega>\epsilon$ strong.
1.657	1.669	Hardystonite $2CaO.ZnO.2SiO_2$	Tetrag. Granular	{001}good, {100}, {110}rare.	White	H=3 G=3.4	Gelat. F=dif.
1.636	1.675	Pyrosmalite $9(Fe,Mn)O.8SiO_2.FeCl_3.7H_2O$	Trig.	{0001} perf. {$10\bar{1}0$} poor.	Colorless, green, brownish.	H=4 G=3.1	Decpd. by acid. F=3 to a black glass. Nearly colorless in section. Thick plates pleoc. Abs.: $\omega>\epsilon$.
1.59	1.675	Chloromagnesite $MgCl_2$	Hex. Plates		Colorless	Soft	Very deliquescent. F=1.
1.500	1.681	Dolomite $CaO.MgO.2CO_2$	Trig. Rhombs	{$1\bar{1}01$}perf.	White	H=4 G=2.87	Does not effervesce in cold dilute acid. Infus. Data for pure mineral.
1.652	1.685	Schorlite Na_2O, (Fe,Mg)O,Al_2O_3,SiO_2, B_2O_3,H_2O, etc.	Hex. Pris.	None.	Varies	H=7 G=3.2	Iron tourmaline. Insol. F=dif. Pleoc. Abs.: $\omega>\epsilon$ strong.
1.641	1.687	Tourmaline Na_2O, (Fe,Mg,Cr)O, Al_2O_3, SiO_2, B_2O_3, H_2O, etc.	do.	do.	Black	H=7 G=3.3	Chromium tourmaline. Insol. in acid. Fus. Pleoc. strong: ω=green to bluish green, ϵ=yellow.

1.60	1.69	Stilpnomelane $2(Fe,Mg)O.(Fe,Al)_2O_3.5SiO_2.3H_2O$	Plates. Mon.	{001}mic.	do.	H=3 to 4 G=2.77 to 3.4	Chalcodite. Chlorite group. Decpd. by acid. F=4.5. Strongly pleoc.: ω=dark brown and nearly opaque, ϵ=yellowish.
1.691	1.691	Gehlenite CaO, MgO, Al_2O_3, SiO_2	Tetrag.	{001}imperf.	Colorless.	H=6.0 G=3.0	Melilite group. Gelat. F=dif. Isot. in yellow light. Abnormal interference colors. Data for mineral with percentages of åkermanite=35, sarcolite=21, velardenite=36.
1.641	1.694	Spangolite $(AlCl)O.6CuO.SO_3.9H_2O$	Trig. Tab.	{0001}perf.	Dark green, bluish green.	H=2 on {0001} 3 on pyramids. G=3.14	F=3. Pleoc.: ω=green, ϵ=bluish-green.
1.510	1.695	Dolomite $CaO.(Mg, Fe)O.2CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$perf.	White.	H=4 G=2.92	Does not effervesce in cold dilute acid. Infus. Data for mineral with percentages of $CaCO_3$=55, $MgCO_3$=35, $FeCO_3$=10.
1.518	1.698	Ankerite $(Ca,Mg,Fe)O.CO_2$	Trig.	$\{10\bar{1}1\}$perf.	Colorless, etc.	H=3 G=2.95	Data for mineral with percentages of $CaCO_3$=52.6, $MgCO_3$=36.7, $FeCO_3$=10.7. Sol. in acid. Infus.
1.509	1.700	Magnesite $MgO.CO_2$	Trig. Massive.	$\{10\bar{1}1\}$perf.	Colorless, white, etc.	H=3.5 to 4 G=2.96	Sol. in hot acid. Infus. Data for pure $MgCO_3$.
1.698	1.706	Svabite $9CaO.3As_2O_5.CaF_2$	Hex. Pris. Fib.	None.	Colorless.	H=5 G=3.5 to 3.8	Apatite group. Sol. in acid. F=5.
1.705 1.715	1.708 1.720	Vesuvianite $2(Ca,Mn,Mg,Fe)O.(Al,Fe)(OH,F)O.2SiO_2$	Tetrag. Pris.	$\{10\bar{1}0\}$poor.	Variable.	H=6.5 G=3.4	Sol. in acid after ignition. F=3. Pleoc. variable. Abs. weak: $\omega>\epsilon$. Anom. 2V.
1.526	1.716	Ankerite $CaO.(Mg,Fe)O.2CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$perf.	White, etc.	H=4 G=2.97	Sol. in acid. Infus. Data for mineral with percentages of $CaCO_3$=52, $MgCO_3$=26, $FeCO_3$=22.
1.681	1.723	Pyrochroite $MnO.H_2O$	Trig.	{0001}mic.	White.	H=2.5 G=3.26	Difficultly sol. in acid. Infus. Abs.: $\omega>\epsilon$. Luster pearly.
1.527	1.726	Magnesite $(Mg,Fe)O.CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$perf.	do.	H=4 G=3.09	Sol. in hot acid. Infus. Data for mineral with percentages of $MgCO_3$=85, $FeCO_3$=15.
1.72	1.73±	Melanocerite Silicate of Ce,Y,Ca, etc., containing fluorine and boron.	Trig. Tab. {0001}.	Conch.	Deep brown to black.	H=5 to 6 G=4.13	Decpd. by acid. Infus. Very pale yellow in section.
1.714	1.733	Hematolite $8MnO.(Al,Mn)_2O_3.As_2O_5.8H_2O$	Trig.	{0001}perf.	Brown, red, etc.	H=3.5 G=3.4	Sol. in acid. Infus. Luster greasy. In section yellowish to brown. Opt. anom. 2V small.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ε	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.547	1.749	Ankerite $CaO.(Fe,Mg)O.2CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$ perf	White	H=4 G=3.12	Sol. in acid. Infus. Data for mineral with percentages of $CaCO_3$=48.3, $MgCO_3$=11.3, $FeCO_3$=37.9, $MnCO_3$=2.5.
1.63	1.76	Stilpnomelane $2(Fe,Mg)O.(Fe,Al)_2O_3.5SiO_2.3H_2O$	Mon. Hex. plates	{001}mic	Black	H=3 to 4 G=2.71 to 3.4	Chlorite group. Decpd. by HCl. F=4.5. Strongly pleoc.: X=yellowish, Y and Z=dark brown and nearly opaque.
1.577	1.760	Cordylite $Ce_2O_3.3CO_2.BaF_2$	Hex. Pyram	{0001}perf	Wax-yellow	H=4.5 G=4.31	Sol. in HCl. B.b. decrepitates and becomes brown. Pleoc.: ω=greenish yellow, ε=brownish yellow.
B=rather strong.		Cappelenite Borosilicate of Y and Ba.	Hex	None	Green-brown	H=6 to 6.5 G=4.41	Sol. in HCl. F=dif.
1.760	1.768	Corundum Al_2O_3	Trig	{0001}perf. parting.	Red, blue, etc	H=9 G=4.0	Insol. in acid. Infus. Pleoc.: ω=green, ε=blue, etc. Anom., 2V up to 58°.
B=strong		Nordenskioeldine $CaO.SnO_2.B_2O_3$	do	{0001}perf	Sulphur-yellow	H=5.5 to 6 G=4.20	Imperfectly decpd. by HCl. Infus. but sinters.
1.570	1.788	Mesitite $(Fe,Mg)O.CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$perf	White	H=4 G=3.43	Sol. in hot acid. Infus. Data for mineral with per cent. of $FeCO_3$=50, $MgCO_3$=50.
B=strong		Palmerite $3(K,Na)_2O.4PbO.7SO_3$	Mic. hex. plates		Colorless, with pearly luster.	G=3.33	Sol. in HNO_3. Decpd. in boiling H_2O. F=easy.
1.72	1.80	Ferritungstite $Fe_2O_3.WO_3.6H_2O$	Hex. Plates and fib.		Pale yellow		Decpd. by acid. Elongation of fib.+.
1.55	1.80	Remingtonite $CoO.CO_2+nH_2O$	Earthy		Rose-red	H=soft	Sol. in acid. Infus.
B=strong	1.80	Cronstedtite $3(Fe,Mg)O.Fe_2O_3.2SiO_2.3H_2O$	Trig.? Tapering hex. pyramids.	{0001}mic	Black	H=3.5 G=3.34	Chlorite group. Gelat. F=4. Pleoc. marked: Dark reddish brown to nearly opaque.
1.761	1.815	Molybdophyllite $2(Pb,Mg)O.SiO_2.H_2O$	Hex. Lamellar	{0001}perf	Pale green, colorless.	H=3 to 4 G=4.72	F=dif. In section colorless.
1.618	1.818	Smithsonite $ZnO.CO_2$	Trig	$\{10\bar{1}1\}$perf	Colorless, etc	H=5 G=4.4	Sol. in acid. Infus

1.597	1.817	Rhodochrosite $MnO.CO_2$	do	do	Pink	$H=4$ $G=3.70$	Sol. in acid. Infus. Turns black on heating. Data for mineral composed of pure $MnCO_3$.
1.715	1.820	Jarosite $K_2O.3Fe_2O_3.4SO_3.6H_2O$	Trig. Rhombs. Tablets.	$\{0001\}$dist	Yellow	$H=3$ $G=3.2$	Alunite group. Sol. in acid. $F=4.5$. Base divided into six biax. segments.
1.73	1.82	Carphosiderite $3Fe_2O_3.4SO_3.10H_2O$	Trig.? Plates	do	do	$H=4$ to 4.5 $G=2.5$ to 2.7	Sol. in HCl.
1.605	1.826	Rhodochrosite $(Mn,Fe)O.CO_2$	Trig. Rhombs	$\{10\bar{1}1\}$perf	Pink	$H=4$ $G=3.74$	Sol. in acid. Infus. Turns black on heating. Data for mineral with percentages of $MnCO_3=79.3$, $FeCO_3=19.9$, $CaCO_3=0.8$.
1.596	1.830	Siderite $(Fe, Mg)O.CO_2$	Trig	do	Colorless to brown.	$H=4$ $G=3.64$	Sol. in HCl. Infus. Data for mineral with percentages of $FeCO_3=73.2$, $MnCO_3=.22$, $MgCO_3=23.3$, $CaCO_3=1.3$.
1.750	1.832	Natrojarosite $Na_2O.3Fe_2O_3.4SO_3.6H_2O$	Trig. Hex. plates	$\{0001\}$dist	Yellow, brown	$H=3$ $G=3.2$	Alunite group. Sol. in acid. $F=4.5$. Faintly pleoc.: ω=pale yellowish, ϵ=colorless.
1.615	1.849	Siderite $(Fe,Mn)O.CO_2$	Trig	$\{10\bar{1}1\}$perf	Colorless, etc	$H=4$ $G=3.80$	Sol. in acid. Infus. Data for mineral with percentages of $FeCO_3=77.2$, $MnCO_3=15.8$, $MgCO_3=6.6$, $CaCO_3=0.4$.
1.613	1.855	Siderite $FeO.CO_2$	do	do	do	$H=4$ $G=3.78$	Sol. in acid. Infus. Data for mineral with percentages of $FeCO_3=90$, $MgCO_3=5$, $CaCO_3=5$.
$B=0.04\pm$	1.85	Beaverite $CuO.PbO.Fe_2O_3.2SO_3.4H_2O$	Hex. plates		Brown	$G=4.36$	
B=weak (?)		Armangite $3MnO.As_2O_5$	Trig	$\{0001\}$poor	Black	$H=4$ $G=4.23$	Sol. in HCl. F=easy. Streak brown. Not pleochroic.
1.803	1.853	Hoegbomite $MgO.2(Al,Fe)_2O_3$, some TiO_2	do	None	do	$H=6.5$ $G=3.81$	Insol. in acid. Infus. Pleoc. strong. ω=dark brown, ϵ=light yellow-brown. Alteration of pleonaste.
1.60	1.855	Sphaerocobaltite $CoO.CO_2$	do	$\{10\bar{1}1\}$perf	Rose-red, black	$H=3$ to 4 $G=4.1$	Sol. in acid. Infus. Colorless in section.
1.792	1.870	Arseniosiderite $6CaO.4Fe_2O_3.3As_2O_5.9H_2O(?)$	Orth.? Fib., tab. (001).	$\{001\}$perf	Yellow, brown	$H=1$ to 2 $G=3.5$ to 3.9	Sol. in acid. $F=3$. Pleoc. in brownish red. Abs.: $\omega>\epsilon$.
1.633	1.875	Siderite $FeO.CO_2$	Trig	$\{10\bar{1}1\}$highly perf.	Gray, yellow, brown.	$H=4$ $G=3.89$	Sol. in acid. Infus. Data for pure $FeCO_3$.
1.784	1.875	Plumbojarosite $PbO.3Fe_2O_3.4SO_3.6H_2O$	Trig. Hex. plates. Powder.	$\{10\bar{1}1\}$	Brown	$G=3.63$	Alunite group. Sol. in HCl. Pleoc.: ω=dark brownish red, ϵ=pale golden yellow.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.815	1.898	Arseniosiderite $3CaO.2Fe_2O_3.2As_2O_5.6H_2O$(?)	Orth. Pris.		Black; blood-red in splinters.	H=4.5 G=3.57	Variety mazapilite. Sol. in acid. F=2 to 3? Pleoc.: ω=dark reddish brown. ϵ=nearly colorless.
B=low.	1.93	Corkite $2PbO.3Fe_2O_3.P_2O_5.2SO_3.6H_2O$	Trig. Cubic	{0001}easy	Olive, yellow, etc.	H=4 G=4.2±	Alunite group. Sol. in HCl. Abnormal green interference colors. Base divided into six biax. segments.
B=mod. or low.	1.96	Beudantite $2PbO.3Fe_2O_3.As_2O_5.2SO_3.6H_2O$	Trig. Acute rhombs	do	Olive, yellow, brown, black.	H=4 G=4.1±	Alunite group. Sol. in HCl. F=3.5. Abnormal green interference colors. Base divided into six biax. segments.
1.82	2.01	Bismite $Bi_2O_3.3H_2O$(?)	Hex. Tablets	{0001}perf.	White powder	Soft G=4.36	Sol. in HNO_3.
2.00	2.03	Pseudoboléite $5PbCl_2.4CuO.6H_2O$	Tetrag	{001}perf.,{101}perf	Indigo-blue	H=2.5 G=4.85	Sol. in warm dilute HNO_3. F=1. Luster on cleavage pearly.
1.926	2.041	Cumengéite $4PbCl_2.4CuO.5H_2O$	do	{101}very good, {110}good.	do	H=2.5 G=4.8	Sol. in warm dilute HNO_3. F=1. In section it is purer blue than the boléite and pseudoboléite with which it is intergrown.
2.03	2.05	Boléite $9PbCl_2.8CuO.3AgCl.9H_2O$	Tetrag. Cubic	{100}perf.	do	H=2.5 G=5.08	Sol. in warm dilute HNO_3. F=1. Luster on cleavage pearly. Trillings on (001) of three individuals form pseudo-cubic faces. Gelat. F=2.
B=very low.	2.05	Eulytite $2Bi_2O_3.3SiO_2$	Ps. isomet. Tetrah.	{110}imperf.	Grayish, etc.	H=4.5 G=6.11	Gelat. F=2.
2.042	2.050	Pyromorphite $9PbO.3P_2O_5.PbCl_2$	Hex. Pris.	$\{10\bar{1}0\}\{10\bar{1}1\}$traces.	Green, yellow, etc.	H=4 G=7.0±	Sol. in HNO_3. F=1.5. Resinous. Pleoc.: ω=green, ϵ=greenish-yellow. Biaxial.
2.05	2.07	Barysilite $3PbO.2SiO_2$	Trig. Tab.{0001}.	{0001}dist.	Gray, white	H=3 G=6.72	Gelat. F=2.5.
1.94	2.09	Hydrocerusite $3PbO.2CO_2.H_2O$	Hex. Plates		Colorless	Soft G=6.14	Sol. in acids. F=1.5. The data given are for the artificial product.
1.94	2.13	Bismutosphaerite $Bi_2O_3.CO_2$	Fib. concretions, basal tablets.		Yellow, green, brown.	H=3 to 3.5 G=7.3 to 7.4	Sol. in acid. F=1.5

2.118	2.135	Mimetite $9PbO.3As_2O_5.PbCl_2$	Hex	{10$\bar{1}$1}imperf	Yellow, brown, colorless, etc.	H=3.5 G=7.1	Sol. in HNO_3. F=1. Biax. in sections.
2.04	2.15	Matlockite $PbO.PbCl_2$	Tetrag	{001}perf	Yellow, greenish, etc.	H=3 G=7.21	Sol. in warm dilute HNO_3. F=1. Biax.
2.14	2.16	Bellite PbO,Cr_2O_3,As_2O_3, etc.	Hex. Velvety coatings. Acic. c.		Bright crimson, yellow, orange.	H=2.5. G=5.5	F=easy. Faintly pleoc. in pale pink. Abs.: $\omega>\epsilon$.
2.20	2.25	Endlichite $9PbO.3(As,V)_2O_5.PbCl_2$	Hex. Prisms		Yellow	H=3 G=7	Between vanadinite and mimetite. Decpd. by HCl. F=1.5.
2.10	2.26±	Hetaerolite $2ZnO.2Mn_2O_3.H_2O$	Tetrag. Fib. c	{001}perf	Yellowish black	H=6 G=4.55	Zinc hausmannite. Sol. in HCl giving Cl gas. Infus. Pleoc. faint: ω=red-brown, ϵ=nearly opaque.
2.182	2.269	Stolzite $PbO.WO_3$	Tetrag. Pyramidal	{001}{111}imperf	Green, gray, brown, etc.	H=3 G=8±	Isomor. with scheelite. Decpd. by HNO_3. F=2.
	$2.3\pm_{Li}$	Plattnerite PbO_2	Tetrag		Black	H=5 to 5.5 G=8.5	Sol. in HCl. F=2. Streak chestnut-brown. Nearly opaque. Basal section shows six biax. segments.
1.95	2.31	Geikielite $(Mg,Fe)O.TiO_2$	Trig. Rhombs	{10$\bar{1}$1}perf	do	H=6 G=3.98	Slowly sol. in HCl. Infus. Pleoc. faint in red-brown or purple. Abs.: $\omega>\epsilon$.
2.25_{Li}	2.32_{Li}	Ecdemite $4PbO.As_2O_3.2PbCl_2$	Tetrag. Tab. (001). Crusts.	{001}nearly perf	Yellow, green	H=2.5 to 3 G=6.9 to 7.1	Heliophyllite. Sol. in HNO_3. F=1.5(?). In part biax.
2.14	2.34±	Hetaerolite $ZnO.Mn_2O_3$	Tetrag. Fib. c	{001}perf	Black	H=6 G=4.85	Zinc hausmannite. Sol. in HCl giving Cl gas. Infus. Red-brown in section and faintly pleoc.: $\omega<\epsilon$.
2.33_{Li}	2.35_{Li}	Lorettoite $6PbO.PbCl_2$	Massive	{001}highly perf	Orange-yellow	H=3 G=7.4 to 7.6	Sol. in acid. F=1.
2.299	2.354	Vanadinite $9PbO.3V_2O_5.PbCl_2$	Hex. Pris.		Red, yellow, brown.	H=3 G=7±	Resinous. Decpd. by HCl. F=1.5.
2.25_{Li}	2.36_{Li}	Schwartzembergite $7PbO.I_2O_5.3PbCl_2$	Tetrag. or ps. tetrag.	{001}dist	Honey to straw-yellow, reddish.	H=2 to 2.5 G=6.3	Sol. in dilute HNO_3. F=1. Anom. 2V.
2.31_{Li}	2.36_{Li}	Långbanite $mSb_2O_3.nFe_2O_3.pMnO.q(Mn,Si)O_2$	Trig.	None	Iron-black	H=6.5 G=4.6 to 4.8	Difficultly sol. in HCl. Infus. Pleoc. faint in dark, reddish brown. Abs.: $\omega>\epsilon$.
2.304_{Li}	2.402_{Li}	Wulfenite $PbO.MoO_3$	Tetrag. Tab.	{111}perf., {001}{115}less so.	Colorless, yellow, orange, greenish.	H=3 G=6.9	Decpd. by HCl. F=2.
2.15_{Li}	2.46_{Li}	Hausmannite Mn_3O_4	Tetrag. Oct.	{001}nearly perf	Brownish black	H=5 to 5.5 G=4.72 to 4.86	Sol. in HCl with evolution of Cl. Infus. In section dark reddish brown and nonpleoc.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Uniaxial negative group—Continued.

ϵ	ω	Mineral name and composition.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.210	2.481	Pyrophanite $MnO.TiO_2$	Trig. Scaly	$\{02\bar{2}1\}$perf., $\{10\bar{1}2\}$ less so.	Deep blood-red	H=5 G=4.54	Sol. in HCl. Infus. Streak ocher-yellow. In section yellow-red and not pleochroic.
B=mod.	2.50_{Li}	Strueverite $FeO.(Ta,Cb)_2O_5.4TiO_2$	Tetrag.		Iron-black	H=6 G=5.57	Very strongly pleoc.: ω=nearly opaque, greenish in very thin splinters, ϵ=brown.
B=low or mod.	2.50_{Li}	Senaite $(Fe, Mn, Pb)O.TiO_2$	Trig.	None.	Black	H=6 G=5.30	Nearly opaque and nonpleoc. Tw. pl. $(11\bar{2}0)$ common.
2.493	2.554	Anatase TiO_2	Tetrag. Oct.	$\{001\}\{111\}$perf.	Brown, etc.	H=6 G=3.84	Insol. in acid. Infus. Pleoc. in thick section: ω=pale blue or yellowish, ϵ=dark-blue or orange.
B=extr.	2.6_{Li}	Trechmannite $Ag_2S.As_2S_3$	Trig.	$\{10\bar{1}1\}$good, $\{0001\}$ dist.	Scarlet, vermilion.	H=1½ to 2	Brittle. Streak scarlet. Pleoc.: ω=pale reddish, ϵ=clear and colorless. On heating moderately inverts to a biax. form, probably smithite.
2.535_{Li}	2.665_{Li}	Litharge PbO	Tetrag. Tab.$\{001\}$.	$\{110\}$perf.	Reddish	H=2 G=9.13	Sol. in HNO_3. F=1.5 to a yellow glass. Borders crystals of massicot.
B=extr. Near 2.72_{Li}	Greater than 2.72_{Li}	Chalcophanite $(Mn,Zn)O.2MnO_2.2H_2O$	Trig. Tab.$\{0001\}$.	$\{0001\}$perf.	Black	H=2.5 G=3.91	Sol. in HCl with evolution of Cl. Infus. Strikingly pleoc.: ω=nearly opaque, ϵ=deep red.
2.711_{Li}	2.979_{Li}	Proustite $3Ag_2S.As_2S_3$	Trig.	$\{10\bar{1}1\}$dist.	Scarlet	H=2 G=5.6	Decpd. by HNO_3. F=1. Streak scarlet. In section bright red. Pleoc. weak: ϵ=cochineal-red, ω=blood-red.
2.94_{Li}	3.01_{Li}	Hematite Fe_2O_3	do.	$\{0001\}$parting	Red to black	H=5 G=5.2	Sol. in acid. Infus. Streak red. The data given are for the artificial product.
2.881_{Li}	3.084_{Li}	Pyrargyrite $3Ag_2S.Sb_2S_3$	do.	$\{10\bar{1}1\}$dist.	do.	H=2.5 G=5.8	Decpd. by HNO_3. F=1. Tw. pl. $(11\bar{2}0)$. Composition pl. (0001). Tw. pl. $(10\bar{1}4)$. Streak purplish-red. In section red.
2.94_{Li}	3.22_{Li}	Hematite Fe_2O_3	do.	$\{0001\}$parting	do.	H=5 G=5.2	Sol. in acid. Infus. Streak red. Abs.: $\omega>\epsilon$.

Biaxial positive group.

[The minerals of this group are chiefly orthorhombic, monoclinic, or triclinic.]

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=weak	....	1.364	Cryolite $3NaF.AlF_3$	43° $\rho < v$.	X=*b* $Z \wedge c = -44°$. Disp.	Mon. Cubic.	{001}perf. {110}, {101} good.	White, reddish, brownish.	H=2.5 G=3.0	Sol. in H_2SO_4. F=2. Tw. {110}, lamellar.
B=.008	....	1.413	Pachnolite $NaF.CaF_2.AlF_3.H_2O$	76° $\rho < v$ weak.	X=*b* $Z \wedge c = 69°$. Disp. strong.	Mon.	{001}dist.	White.	H=3 G=2.98	Alteration of cryolite. F=1.5. Tw. pl. {100}.
1.438	1.452	1.44	Erionite $(Ca,K_2,Na_2)O.$ $Al_2O_3.6SiO_2.6H_2O$?	....	Z=elong.	Orth. Woolly.	....	do.	G=2.00	Zeolite group. Gelat. F=easy.
1.439	1.469	1.441	Stercorite $Na_2O.(NH_4)_2O.$ $P_2O_5.9H_2O$	36° $\rho > v$ rather strong.	Z=*b* $Y \wedge c = 30°$. Disp. strong.	Mon.?	None.	Colorless.	H=2 G=1.574	Sol. in H_2O. F=1. Section{010}shows two sets of poly. tw. lamellae at about 90°.
1.447	1.459	1.448	Taylorite $5K_2O.(NH_4)_2O.6SO_3$	36° $\rho > v$ rather strong.	....	Concretions.	....	do.	H=2	Sol. in H_2O. F=1.5(?).
B=.012	....	1.45	Brewsterite $(Sr,Ba,Ca)O.Al_2O_3.$ $6SiO_2.5H_2O$	65°± $\rho > v$ weak.	Z=*b* $X \wedge c = 22°$.	Mon. Elong. *c*.	{010}perf. {100}.	White.	H=5 G=2.45	Zeolite group. Decpd. by acids. F=3.
1.461	1.476	1.463	Picromerite $MgO.K_2O.2SO_3.$ $6H_2O$	48° $\rho > v$ mod.	Y=*b* $X \wedge c = -1°$.	Mon. Crusts.	{201}perf.	do.	H=2.5 G=2.1	Sol. in H_2O. F=2.
1.459	1.470	1.461	Aluminite $Al_2O_3.SO_3.9H_2O$	Large.	Elong.	Mon. Fib. Earthy.	....	do.	H=1 to 2 G=1.66	Insol. in H_2O. Sol. in acid. Infus.
B=.005	....	1.465	Mordenite $(Ca,Na_2,K_2)O.Al_2O_3.$ $10SiO_2.6\frac{2}{3}H_2O$	do.	X=*b* $Z \wedge c = 73.5°$.	Mon. Tab.{010}. Fib. *c*.	{010}perf.	Yellow, pink, etc.	H=3 to 4 G=2.15	Zeolite group. Partly decpd. by acid. F=4 to 5 with intumescence.
1.469	1.479	1.470	Boussingaultite $(NH_4)_2O.MgO.$ $2SO_3.6H_2O$	50° $\rho > v$ slight.	Y=*b* Z near *a*.	Mon.	None.	White.	H=2 G=1.68 to 1.72	Sol. in H_2O. F=1.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.469	1.473	1.47	Tridymite SiO_2	Large	$X=b$ $Z=c$.	Orth Ps. Hex. Tab.{0001}.	Indistinct	Colorless	H=6.5 G=2.30	Sol. in boiling Na_2CO_3. Infus.
1.46	1.51	1.47	Lansfordite $MgO.CO_2.5H_2O$	61°	Opt. pl. $\perp${010}	Mon. Tab.	{001}perf	do	H=2.5 G=1.73	Sol. in acid. Infus. Alters on exposure to air to nesquehonite.
1.466	1.494	1.475	Carnallite $KCl.MgCl_2.6H_2O$	70° $\rho<v$	$Z=a$ $X=c$.	Orth		White, reddish, etc.	H=2.7 G=1.60	Deliquescent. F=1 to 1.5.
1.464	1.485	1.474	Thenardite $Na_2O.SO_3$	84° $\rho>v$ weak.	$X=b$ $Y=c$.	do	{001}dist	White, brown.	H=2 to 3 G=2.69	Very sol. in H_2O. F=1.5 to 2.
1.474	1.483	1.476	Alunogen $Al_2O_3.3SO_3.16H_2O$	69°	$X=b$ $Z\wedge c=42°$.	Mon. Tab.{010}. Fib. *c*.		White	H=1.5 G=1.64 to 1.67	Keramohalite. Sol. in H_2O. Infus.
1.471	1.486	1.478	Melanterite $FeO.SO_3.7H_2O$	86° $\rho>v$ weak.	$Y=b$ $Z\wedge c=-61°$. Disp.	Mon. Elong. *c*.	{001}perf {110}good.	Green (when fresh), yellow.	H=2 G=1.90	Sol. in H_2O. Tastes astringent. F=easy. Alters on exposure to dry air.
1.478	1.482	1.479	Ferrierite $2RO.Al_2O_3.5SiO_2$ $R=Mg:Na_2:H_2$ $=1:1:1$	50°	$Y=b$ $Z=c$.	Orth Blades{100}. Elong. *c*.	{100}perf	White	H=3 to 3¼ G=2.15	Insol. in HCl. F=3 to 3½.
1.472	1.487	1.479	Pisanite $(Fe,Cu)O.SO_3.7H_2O$	Very large Disp. weak.	$Y=b$ X near *c*.	Mon.	{001}easy	Blue	H=2 to 3 G=1.9	Sol. in H_2O. F=3 to 4. Alters readily by dehydration.
(a)	(a)	(a)	Boothite $CuO.SO_3.7H_2O$		$Y=b$ X near *c*.	Mon. Fib. *c*.	{001}imperf	do	H=2.5 G=1.94	Sol. in H_2O. Fus. Colorless in section. Decomposes to chalcanthite on exposure to dry air.
1.475	1.487	1.480	Misenite $K_2O.2SO_3.H_2O$	Large	Z elong.=33°	Mon.? Silky fib.		White		Sol. in H_2O. F=easy.

1.475	1.488	1.480	Dietrichite $(Zn,Fe,Mn)O.Al_2O_3.4SO_3.22H_2O$	do	$X=b$. $Z\wedge c=29°\pm$.	Mon. Fib. *c*.		do	H=2	Sol. in H_2O. Infus.
B=weak		1.480	Faujasite $Na_2O.CaO.2Al_2O_3.10SiO_2.20H_2O$			Oct	{111}dist	do	H=5 G=1.92	Zeolite group. Decpd. by acid. F=3. Uniax.+. In eight segments from loss of H_2O.
B=0.001 to 0.009		1.481	Gmelinite $(Na_2,Ca)O.Al_2O_3.4SiO_2.6H_2O$	Small		Ps. trig	{10$\bar{1}$0} easy	Colorless, yellowish, greenish.	H=4 G=2.17	Zeolite group. Decpd. by acid. F=3. Tw. axis *c*.
B=0.003		1.48	Phillipsite $(K_2,Ca)O.Al_2O_3.4SiO_2.4\frac{1}{2}H_2O$	70° $\rho<v$.	$Y=b$. $Z\wedge a=11°$ to 30°.	Mon. Fib. *a*.	{001} {010} rather dist.	Colorless	H=4 G=2.2	Zeolite group. Gelat. F=3. Tw. pl. {001} and {011} penet. simulating orth. or tetrag. forms.
1.480	1.493	1.482	Natrolite $Na_2O.Al_2O_3.3SiO_2.2H_2O$	63° $\rho<v$ weak.	$X=a$. $Z=c$.	Orth Needles *c*.	{110} perf. {010} imperf.	White	H=5 G=2.25	Zeolite group. Gelat. F=2. Tw. pl. {110} {100}, rarely {301}.
1.479	1.488	1.483	Zinc-copper melanterite. $CuO.ZnO.2SO_3.14H_2O$	Large Disp. weak.	$Z=b$. $Y\wedge$ elong. large.	Mon.? Fib.		Light blue-green.	H=2 G=2.02	Sol. in H_2O. F=easy. Decomposes to the pentahydrate on exposure to dry air.
1.485	1.488	1.485	Chabazite $(Ca,Na_2)O.Al_2O_3.4SiO_2.6H_2O$	Small		Ps. trig	{10$\bar{1}$1} dist.	Colorless, white, red, etc.	H=4 to 5 G=2.1	Zeolite group. Decpd. by acid. F=3 with intumescence. Tw. pl. {10$\bar{1}$1}. (See Uniaxial group, p. 192.)
1.484	1.496	1.487	Tamarugite $Na_2O.Al_2O_3.4SO_3.12H_2O$	60° Disp. slight.	Z near *b*. $Y\wedge c=30°\pm$.	Mon. or tric. Laths {100}. Fib. *c*.		Colorless	H=1 G=2.03	Sol. in H_2O. Fus. Poly. tw.
1.473	1.511	1.490	Fluellite $AlF_3.H_2O$	85° $\rho<v$ rather strong.	$Y=a$. $Z=c$.	Orth	{111} indist.	do	H=3 G=2.17	Insol. in acid. Infus.
B=mod.		1.491	Cyanochroite $K_2O.CuO.2SO_3.6H_2O$	49° $\rho>v$.	$Y=b$. $X\wedge c=4°$.	Mon. Crusts.		Clear blue.		Isomor. with picromerite. Sol. in H_2O. F=1(?).
1.494	1.497	1.495	Arcanite $K_2O.SO_3$	67° $\rho>v$ mod.	$X=b$. $Z=c$.	Orth	{010}{001}good		G=2.67	Sol. in H_2O. Artificial.
1.495	1.504	1.496	Struvite $(NH_4)_2O.2MgO.P_2O_5.12H_2O$	37° $\rho<v$ strong.	$Z=b$. $X=c$.	do	{001} perf. {010} good.	Colorless, yellow.	H=2 G=1.72	Sol. in acids. F=3.

a Near pisanite.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.498	1.505	1.499	Heulandite $CaO.Al_2O_3.6SiO_2.5H_2O$	34°± ρ>υ.	Z=*b* Y∧*c*=6°±.	Mon. Tab. {010}.	{010} perf.	White	H=4 G=2.2	Zeolite group near stilbite. Decpd. by HCl. F=2. Opt. pl. sometimes //{010}.
1.498	1.503	1.50	Wellsite $(Ba,Ca,K_2)O.Al_2O_3.3SiO_2.3H_2O$	39°±	Z=*b* X∧*c*=−52°.	Mon.	None	Colorless	H=4 to 4.5 G=2.28 to 2.37	Zeolite group. Decpd. by acid. F=3. Complex tw.
1.499	1.538	1.503	Uranothallite $2CaO.UO_2.4CO_2.10H_2O$	42° ρ>υ perc.	X=*a*	Orth. Crusts.	{100} perf.	Siskin-green	H=2.5 to 3	Sol. in acid. Infus.
1.501	1.510	1.503	Prosopite $CaF_2.2Al(F,OH)_3.H_2O$	63° ρ>υ strong.	Y=*b* Z∧*c*=−50°.	Mon. or tricl. Tab. {010}.	{211} dist.	Colorless	H=4.5 G=2.88	Decpd. by H_2SO_4. Infus.
1.497	1.525	1.503	Thomsonite $(Na_2,Ca)O.Al_2O_3.2SiO_2.2\frac{1}{2}H_2O$	54°± ρ>υ strong.	X=*a*. Z=*b*.	Orth. Fib. *c*. Lamellar {010}.	{010} perf. {100} good.	White	H=5 G=2.36	Zeolite group. Gelat. F=2.
1.491	1.520	1.504	Ulexite $Na_2O.2CaO.5B_2O_3.16H_2O$	Mod.	X=*b* Y∧*c*=23° to 0.	Mon. Fib. *c*. "Cotton balls."		do.	H=1 G=1.65	Sol. in acids. Slightly sol. in H_2O. F=1 with intumescence.
1.503	1.508	1.505	Harmotome $(K_2,Ba)O.Al_2O_3.5SiO_2.5H_2O$	43°	Z=*b* X∧*c*=60°.	Mon. Pris. *a*.	{010} easy {001} less so.	do.	H=4.5 G=2.5	Zeolite group. Decpd. by HCl. F=3.5 Tw. pl. {001} cruciform.
1.505	1.506	1.505	Mesolite $Na_2O.2CaO.3Al_2O_3.9SiO_2.8H_2O$	86° ρ>υ strong.	Z near *a* Y∧*c*=5°±.	Tric. Needles *c*.	{110}{1$\bar{1}$0}perf.	White, gray	H=5 G=2.27	Zeolite group. Gelat. F=easy. Tw. pl. {100} common. 2V changes rapidly with temp.
B=0.002		1.5	Pseudomesolite $2CaO.Na_2O.3Al_2O_3.9SiO_2.8H_2O$	Very small	Z∧*c*=20°	Tric. Fib. *c*.	{110}{1$\bar{1}$0}perf.	White	H=5 G=2.22	Near mesolite. Gelat. F=2. X and Y are // to diagonals of rhombs in cross sections.
1.495	1.528	1.507	Bischofite $MgO.CO_2.6H_2O$	79° ρ>υ.	X=*b* Y∧*c*=9½°.	Mon. Fib.		Colorless	H=1.5 G=1.591	Sol. in H_2O. Fus.

1.504	1.545	1.508	Ussingite $2Na_2O.Al_2O_3.6SiO_2.H_2O$	39°	$Z=c$?	Tric.	{001} perf. or lamellar tw.		H=6 to 7 G=2.50	
B=0.001		1.508	Leucite $K_2O.Al_2O_3.4SiO_2$	Small	$Z=a$	Orth. Ps. isomet.		Colorless	H=6 G=2.5	Decpd. by acid. Infus.
1.504	1.575	1.510	Pirssonite $CaO.Na_2O.2CO_2.2H_2O$	33°	$X=a$. $Z=b$.	Orth. Elong. c. Tab. {010}.	None	do	H=3 G=2.35	Effervesces in acid. Slightly sol. in H_2O. F=1.5.
B=0.003		1.51	Phillipsite $(K_2,Ca)O.Al_2O_3.4SiO_2.4\frac{1}{2}H_2O$	70° $\rho<v$.	$X=b$. $Z\wedge a=11°$ to 30°.	Mon. Fib. a.	{001} {010} rather dist.	do	H=4 G=2.2	Zeolite group. Gelat. F=3. Tw. pl. {001} and {011}, penet. simulating orth. or tetrag. forms.
1.504	1.516	1.510	Petalite $Li_2O.Al_2O_3.8SiO_2$	84° $\rho<v$ small.	$Z=b$. $X\wedge a=-8°$. Disp.	Mon.	{001} perf. {201}	Red, green, colorless.	H=6 G=2.4	Insol. in acid. F=5.
1.514	1.520	1.515	Gonnardite $(Ca,Na_2)O.Al_2O_3.5SiO_2.5\frac{1}{2}H_2O$	52°	Y=fib. X ⊥ laths.	Orth. Fib.		White	H=4.5 to 5 G=2.25	Zeolite group.
1.514	1.533	1.518	Newberyite $2MgO.P_2O_5.7H_2O$	45° $\rho<v$.	$X=a$. $Z=c$.	Orth. Tab. {100}.	{010} perf. {001} imperf.	do	H=3 G=2.10	Sol. in HNO_3.
1.516	1.533	1.518	Felsoebanyite $2Al_2O_3.SO_3.10H_2O$	48° $\rho>v$ perc.	$Z=c$. X=elong.	Orth. Scales {001}.	{001} perf.	Colorless	H=1.5 G=2.33	Sol. in acid. Infus. Lath-shaped cleavage pieces.
1.515	1.525	1.518	Monetite $2CaO.P_2O_5.H_2O$	Rather large.	X emerges from {100}.	Tric. Rhomb.	{100} dist.	do	H=3.5 G=2.75	Sol. in acid. F=3.
1.509	1.561	1.52	Larderellite $(NH_4)_2O.5B_2O_3.5H_2O$	60°±	$X=b$. Y near a. $Z\wedge c=$ large.	Mon. Tab. {100} with rhombic outline and angle 66°.	{001} perf.	do	Soft.	Cleaved rhombs resemble hexagonal plates.
1.510	1.543	1.520	Bobierite $3MgO.P_2O_5.8H_2O$	71° $\rho<v$ weak.	$Y=b$. $Z\wedge c=29°$.	Mon. Needles c.	{010}	do	H=1 to 2 G=2.41	Sol. in acid. Fus.
B=0.03		1.52	Hautefeuillite $3(Mg,Ca)O.P_2O_5.8H_2O$	55° $\rho<v$.	$Y=b$. $Z\wedge c=45°$ Disp. strong.	Mon. Lamellar. Radiated c.	{010} perf.	do	H=2.5 G=2.44	Near bobierite. Sol. in acid with difficulty. Fus.
1.520	1.530	1.523	Gypsum $CaO.SO_3.2H_2O$	58° $\rho>v$ perc.	$Y=b$. $X\wedge c=37\frac{1}{2}°$. Disp. strong.	Mon. Tab. {010}.	{010} mic.	White	H=1.5 to 2 G=2.32	Sol. in HCl. F=2.5 to 3. Tw. and comp. pl. {100}.
1.521	1.533	1.523	Mascagnite $(NH_4)_2O.SO_3$	52° $\rho>v$ feeble.	$Z=a$. $X=c$.	Orth. Elong. c.	{001} dist.	Colorless, yellowish, greenish.	H=2 G=1.76	Sol. in H_2O. Tastes pungent and bitter. F=1. Volatile. Tw. pl. {110}.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.518	1.588	1.523	Hatchettite $C_{28}H_{78}$	33° ± $\rho<v$ rather strong.	$Z=c$	Orth	{001}	White	H=1 G=0.96	Sol. in oils, but not in acids. Fuses at 80° C.
1.508	1.586	1.525	Sideronatrite $2Na_2O.Fe_2O_3.4SO_3.7H_2O$	58° $\rho>v$ strong.	$Z=c$. $Y=b$.	Orth. Fib. *c*.	{100} perf.	Orange to straw-yellow.	H=2 to 2.5 G=2.15 to 2.36	Sol. in acid. F=2. Pleoc.: X=colorless, Y=very pale amber-yellow, Z=pale amber-yellow.
1.508	1.550	1.526	Hintzeite $K_2O.4MgO.11B_2O_3.18H_2O$	81° Disp. not perc.	$Y=b$. $Z \wedge c=65°$.	Mon	{100} {001} perf.	White	H=4.5 G=2.13	Sol. in acid. F=1.
1.507	1.573	1.529	Copiapite $2Fe_2O_3.5SO_3.16H_2O$	73° ± $\rho>v$ rather strong.	Z bisects acute angle.	Orth. Rhombic tablet {001} with angle 77½°.	001 perf.	Sulphur to citron-yellow.	H=2.5 G=2.10	Sol. in acid. F=4.5 to 5. Pleoc.: X = yellowish green, Y=very pale yellow, Z=sulphur-yellow.
1.525	1.536	1.529	Albite $Na_2O.Al_2O_3.6SiO_2$	74° $\rho<v$ weak.	On {010} $X' \wedge$ {001}=24°. On {001} $X' \wedge$ {010}=3½°.	Tric.	{010} {001} perf.	Colorless	H=6 G=2.605	Feldspar group. Data for $Ab_{100}An_0$. Insol. F=4. Poly. tw. {010} almost universal. Other laws common.
1.522	1.544	1.530	Tavistockite $3CaO.Al_2O_3.P_2O_5.2H_2O$?	74° ± Disp. not perc.	$Z=c$. $Y=a$.	Orth. Acic. *c*.	{100} perf.	White		Difficultly sol. in acid. Infus.
1.525	1.550	1.53	Wapplerite $2CaO.As_2O_5.8H_2O$	35° $\rho<v$.	Z near *b*. Ext. on {010} 20½°. Disp. perc.	Mon. or tric. Equant.	{010} perf.	do.	H=2 to 2.5 G=2.48	
1.527	1.540	1.530	Hydromagnesite $4MgO.3CO_2.4H_2O$	Medium large.	$Y=c$ or $X=c$. $Y=a$.	Orth. Tufts. Fib. *c*. Tab. {100}.	One perf.	do.	H=3.5 G=2.16	Sol. in acid. Infus.
1.527	1.583	1.532	Quetenite $MgO.Fe_2O_3.3SO_3.13H_2O$	34° $\rho>v$ rather strong.	X or Y ⊥ cleav.	Mon.	Pris.	Pale reddish brown.	H=3 G=2.12	Sol. in acid. F=4.5 to 5. Pleoc.: X and Y=colorless, Z=rather deep orange-yellow or orange-brown.

1.530	1.545	1.533	Echellite $(CaNa_2)O.2Al_2O_3.3SiO_2.4H_2O$	50°	Y=c long. X ⊥ perf. cleav.	Orth. Fib. Needles.	One perf.	Colorless	H=5.	Decpd. by acid.
1.533	1.575	1.534	Fibroferrite $Fe_2O_3.2SO_3.10H_2O$	Nearly 0	Z//elong.	Orth. Fib. *c*.		Pale yellow	H=2 G=1.86	Sol. in H_2O. F=4.5 to 5. Pleoc.: X and Y nearly colorless, Z=pale yellow.
1.517	1.565	1.534	Hydroboracite $CaO.MgO.3B_2O_3.6H_2O$	Rather large $\rho < v$ perc.	Y=*b*. $X \wedge c=31°$.	Mon Fib. *c*.	{100}{010}perf.	White	H=2 G=2.0	Sol. in acid. F=2.
1.525	1.552	1.534	Wavellite $3Al_2O_3.2P_2O_5.13(H_2O,2HF)$	72° $\rho > v$ small.	Z=*c*. X=*b*.	Orth. Radiating fib. *c*.	{101} {010} rather perf.	White, yellow, green.	H=3 to 4 G=2.3 to 2.5	Sol. in HCl. Infus.
B=very strong.		1.535	Bromcarnallite $MgBr_2.KBr.6H_2O$	87° Disp. slight.	X=*a*. Z=*b*.	Orth. Ps. tetrag.	None.		H=2	Tw. {110}.
1.523	1.586	1.535	Kieserite $MgO.SO_3.H_2O$	57° $\rho > v$ mod.	Y=*b*. $Z \wedge c=76.5$. Disp. dist.	Mon.	{111}{113}perf. {101}{012} {111}good.	White.	H=3.5 G=2.57	Slowly sol. in H_2O. F=2 to 3.
1.530	1.595	1.543	Copiapite $2Fe_2O_3.5SO_3.18H_2O$	Mod. $\rho > v$ rather strong.	X=*c*. Z. bisects acute angle.	Orth. Rhombic tablets {001}, 77½°. Elong. *a*.	{001}perf.	Yellow, reddish, violet.	H=2.5 G=2.10	Sol. in acid. F=4.5 to 5. Pleoc.: X=yellowish green, Y=very pale yellow, Z=sulphur-yellow.
B=0.013±		1.54±	Chrysotile $3MgO.2SiO_2.2H_2O$	Small	Z=*c*.	Orth. Fib. *c*.	{010}.	Green, brown, yellow.	H=4 G=2.5	Serpentine. Decpd. by acids. F=6. Pleoc. faint. Abs.: Z>Y>X.
1.541	1.554	1.545	Sussexite $2(Mn,Zn,Mg)O.B_2O_3.H_2O$	Large	Z=*c*.	do		White	H=3 G=3.12	Sol. in HCl. F=2 to a black mass.
1.539	1.551	1.545	Brushite $2CaO.P_2O_5.5H_2O$	86°	Z=*b*. $X_{Li} \wedge c=9.2°$. $X_{Tl} \wedge c=11.2°$.	Mon. Flattened {010} Elong. *c*.	{010}perf. {301}perf.	do	H=2 G=2.25±	Sol. in dilute acids. F=3.
1.545	1.551	1.546	Eudidymite $Na_2O.2GlO.6SiO_2.H_2O$	30° $\rho > v$ dist.	Y=*b*. $Z \wedge c=-58\frac{1}{2}°$.	Mon. Tab. {001}.	{001}perf. {551}imperf.	do	H=6 G=2.55	Insol. in acid. F=2.5 to 3. Tw. pl. {001} lamellar always present.
1.541	1.564	1.547	Voglite Hydrous carbonate of U, Ca, Cu	60° $\rho < v$ very strong.	Ext. on plates Z′ to elong. 33°. X nearly ⊥ plates.	Tric. (?) Scales.		Emerald-green	Soft.	Poly. tw. lamellae // plates. Pleoc. strong: X and Y= deep bluish green, Z=pale yellowish.
1.544	1.572	1.548	Botryogen $2MgO.Fe_2O_3.4SO_3.15H_2O$	41° $\rho < v$.	X=*b*. $Z \wedge c \pm -12°$.	Mon. Reniform.	{110}dist. {010}perf.	Red to yellow.	H=2 G=2.1	Partly sol. in boiling H_2O. Sol. in acid. F=4.5 to 5. Pleoc.: X=bright yellow, Y=pale red, Z=deep orange-red.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.530	1.592	1.550	Copiapite $2Fe_2O_3.5SO_3.18\pm H_2O$	69° $\rho>\upsilon$ rather strong.	X=*b*	Mon. Tab. {010}. Fib.	{010} perf., {100} less so.	Yellow, reddish violet.	H=2.5 G=2.21	Sol. in H_2O. F=4.5 to 5. Pleoc.: X=yellowish green, Y=very pale yellow, Z=sulphur-yellow.
1.550	1.557	1.553	Andesine Ab_3An_2	88°	On{010}$X'\wedge${001}=8°. On{001}$X'\wedge${010}=2°.	Tric.	{001}{010}perf.	Colorless, etc.	H=6 G=2.676	Feldspar group. $Ab_{60}An_{40}$. Insol. in acid. F=4 to 4.5. Poly. tw.{010} almost universal. Other laws common.
B=0.016	....	1.554	Grothine Silicate of Ca, Al, Fe.	Medium $\rho<\upsilon$.	Y=*c* Z=*a*.	Orth Tab.{010}.	....	Colorless	G=3.09	Easily decomposed by H_2SO_4. Infus.
1.533	1.635	1.555	Rhomboclase $Fe_2O_3.4SO_3.9H_2O$	Small	Z=elong	Rhombic plates.	{001}	do	....	
....	....	1.555±	Soumansite Phosphate of Al and Na with H_2O and F.	0 to 70°	Z=*c*	Ps. tetrag. Oct.	....	....	H=4.5 G=2.87	Sol. in acid. Nearly infus. Basal section divides into four segments.
1.491	1.650	1.555	Whewellite $CaO.C_2O_3.H_2O$	84° $\rho<\upsilon$ weak.	X=*b* $Z\wedge c=-11°$.	Mon.	{001}{010} {110}{101}.	Colorless	H=2.5 G=2.23	Sol. in acid. Infus. Tw. pl. {101} heart-shaped.
1.551	1.582	1.558	Variscite $Al_2O_3.P_2O_5.4H_2O$	55° $\rho<\upsilon$ slight.	X=*a* Z=*c*.	Orth Laths{010}, elong. *c*.	....	Green	H=4 G=2.54	Sol. in HCl after ignition. Infus. On gentle heating changes to deep lavender. Pleoc. faint: X=colorless, Y and Z=pale green.
1.555	1.563	1.559	Anemousite Feldspar.	Very large $\rho>\upsilon$ slight.	On {001} $X'\wedge a$=1° to 5°. On {010} $X'\wedge a$=2° to 11°. Z=near ⊥{001}. Y=near ⊥{001}.	Tric.	{001}{010}perf.	Colorless	H=6	Feldspar group. $Ab_8An_{10}Cg$.
1.494	1.692	1.561	Humboldtine $FeO.C_2O_3.2H_2O$	Large	X=*a* Z=*c*.	Orth. Pris.	{110} very perf., {100}{010} less so.	Yellow	H=2 G=2.28	Sol. in acids. Pleoc.: X=very pale yellowish green, Y=pale greenish yellow, Z=intense yellow.

1.559	1.568	1.563	Labradorite Ab_2An_3	79°	On {010} X′∧{001}=21°. On {001} X′∧{010}=9°.	Tric.	{001}{010}perf.	Colorless	H=6 G=2.70	Feldspar group, $Ab_{40}An_{60}$. Insol. in acid. Infus. Poly. tw. {010} almost universal. Other laws common.
1.560	1.574	1.565	Elpidite $Na_2O.ZrO_2.6SiO_2.3H_2O$	75° $\rho<v$ dist.	X=c. Z=a.	Orth. Elong.c.		White to brick-red.	H=7 G=2.58	
1.566	1.587	1.566	Gibbsite $Al_2O_3.3H_2O$	Small (varies) $\rho>v$ dist. or $\rho<v$ dist.	Y=b. Z∧c=−25°± or X=b.	Mon. Hex. tab. {001}. Fib.	{001}eminent.	White, greenish, etc.	H=3 G=2.35±	Sol. in H_2SO_4. Infus.
1.565	1.580	1.568	Isoclasite $4CaO.P_2O_5.5H_2O$		X=b. Z∧c=small.	Mon. Acic. c.	Clinodiagonal, perf.	White	H=1.5 G=2.92	Sol. in HCl. Fus.
B=0.010		1.57	Phillipsite $(K_2,Ca)O.Al_2O_3.4SiO_2.4\frac{1}{2}H_2O$	2H=85±	X=b. Z∧c=25 to 44°.	Mon. Fib. a.	{001}{010} rather dist.	do	H=4 G=2.2	Zeolite group. Decpd. by acid. F=3. Tw. pl.{001} {011}penet. simulating tetrag. or orth. forms.
1.555	1.585	1.57	Tengerite Y,Gl,CO_3	Large	X=elong.	Fib. Powder.		do		Sol. in acid.
1.569	1.582	1.570	Wagnerite $3MgO.P_2O_5.MgF_2$	26± $\rho>v$ perc.	Z∧c=21½°. Y=b. Disp. weak.	Mon.	{100}{110} imperf.	Colorless, yellow, flesh-red, greenish.	H=5 G=3.0	Sol. in acids. F=4.
1.563	1.596	1.571	Hoernesite $3MgO.As_2O_5.8H_2O$	60	X=b. Z∧c=31°±.	Mon. Tab. {010}, elong. c.	{010}perf	White	H=1 G=2.60	Sol. in acid. F=2 to 3?
1.576	1.579	1.576	Penninite $5(Mg,Fe)O.Al_2O_3.3SiO_2.4H_2O$	0± $\rho<v$ strong.	Z∧c=0± Y=b.	Mon Plates{001}.	{001}mic.	Green	H=2.5 G=2.7±	Decpd. by H_2SO_4. F=dif. Pleoc.: Z=nearly colorless, X and Y green. Abnormal blue interference colors without extinction.
1.571	1.614	1.576	Anhydrite $CaO.SO_3$	42° $\rho<v$	X=c. Z=a.	Orth.	{001}very perf. {010}perf. {100}less so.	Colorless	H=3 G=2.93	Sol. in HCl. F=3.
1.574	1.588	1.576	Augelite $2Al_2O_3.P_2O_5.3H_2O$	51°	Y=b. Z∧c=−34°.	Mon. Tab.{001}.	{110}perf. {$\bar{1}$01}good.	do	H=5 G=2.70	Nearly insol. in acid. Infus.
1.578	1.583	1.579	Bavenite $3CaO.Al_2O_3.6SiO_2.H_2O$	47°	Z=b. X∧c=2°.	Mon. Flattened {100}. Fib.	{010}good	White	H=5.5 G=2.72	Zeolite group.
1.580	1.589	1.580	Sheridanite $3MgO.Al_2O_3.2SiO_2.3H_2O$	Small	Z∧c=5° to 10°		{001}mic.		G=2.70	Chlorite group.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.014		1.6±	Manandonite $2Li_2O.7Al_2O_3.2B_2O_3.6SiO_2.12H_2O$	2E=25° to 30°.	Z sensibly ⊥ cleav.	Ps. hex	{0001}mic	Colorless	G=2.89	Decpd. by H_2SO_4. F=easy. Basal section divides into six segments with the opt. pl. parallel to the hex. edge.
1.580	1.589	1.580	Ripidolite $5(Mg,Fe)O.Al_2O_3.3SiO_2.4H_2O$	0 to 36° ρ<υ perc.	Z near *c*	Mon. Plates	{001}mic	Green	H=2.5 G=2.7	Chlorite group. Decpd. by hot conct. H_2SO_4. F=5 to 5.5. Pleoc.: X and Y pale yellowish green, Z=colorless.
B=rather strong.		1.58±	Cookeite $(Li,Na)_2O.3Al_2O_3.4SiO_2.6H_2O$	0 to 50°		Hex. Plates	{0001}mic	Pink, etc.		B. b. fuses and exfoliates. Base is divided into six biax. segments with uniax. center.
1.582	1.593	1.582	Chrome clinochlore $10(Mg,Fe)O.2(Cr,Al)_2O_3.5SiO_2.6H_2O$	Small	Y=*b* Z∧*c*=2° to 7°.	Mon. Hex. plates.{001}. Fib.	{001}perf	Lavender	H=2.5 G=2.7	Chlorite group, F=5. Data for mineral with 1.8 per cent Cr_2O_3 and little Fe.
1.583	1.593	1.583	Eakleite $5CaO.5SiO_2.H_2O$	Very small	Z=elong	Orth. (?) Fib.	Perfect along fib.	Colorless to pink.	H=6.5 G=2.70	Easily sol. in acid with separation of flaky silica. F=2.5.
1.578	1.591	1.585	Kupfferite $MgO.SiO_2$	Large	Y=*c*	Orth	{110}perf. a t 60°.		G=2.86	Amphibole group. Data on pure artificial mineral.
1.585	1.596	1.586	Clinochlore $5(Mg,Fe)O.Al_2O_3.3SiO_2.4H_2O$	0 to 90° ρ<υ.	Y=*b* Z∧*c*=2° to 7°	Mon. Plates {001} and fib.	{001}perf	Green	H=2.5 G=2.7	Chlorite group. Decpd. by hot conct. H_2SO_4. F=5 to 5.5. Pleoc.: X and Y green to brown, Z yellow, etc. Abs.: X>Y>Z.
B=low.		1.587	Rumpfite $7MgO.8Al_2O_3.10SiO_2.14H_2O$	0 to 10°	X∧*c*=0	Scales	{001}mic	Greenish-white	H=1.5 G=2.68	Chlorite group. Insol. in acid. Infus.
1.584	1.594	1.589	Celsian $BaO.Al_2O_3.2SiO_2$	87°	Y=*b* Z∧*a*=28°.	Mon	{001}perf. {010}good.	Colorless	H=6 G=3.37	Barium feldspar. Sol. in HCl. Infus.

B=low.	....	1.59	Garnierite .... $(Ni,Mg)O.SiO_2.nH_2O$	Small	$Z=c$	Orth. (?) .... Elong. c.	....	Apple-green ...	H=3 G=2.5±	Serpentine group. Decpd. by HCl. Infus.
1.560	1.631	1.591	Hambergite .... $4GlO.B_2O_3.H_2O$	88° .... $\rho>v$ weak.	$X=a$ .... $Z=c$.	Orth. Pris. c..	{010}perf. ...... {100}good.	White	H=7.5 G=2.35.	Insol. except in HF. Infus.
1.586	1.598	1.59	Custerite .... $3CaO.CaF.2SiO_2.H_2O$	60° .... $\rho>v$ strong.	$X=b$ .... $Y\wedge a=6°$.	Mon.	Basal and pris.	.....do	H=5 G=2.96	Separates gelat. silica. F=dif. Poly. tw.{001}.
1.591	1.627	1.592	Catapleiite .... $(Na_2,Ca)O.ZrO_2.3SiO_2.2H_2O$	25° .... $\rho<v$ slight.	Ax. pl. nearly ⊥ edge {10$\bar{1}$0}	Mon. Hex. tab.	{10$\bar{1}$0}perf. .... {10$\bar{1}$1}{10$\bar{1}$2} imperf.	Yellow, brownish, bluish.	H=6 G=2.75	Gelat. F=3. Section{0001} shows trillings and very complex tw. grating. Hex. above 120° to 200° C.
1.586	1.614	1.592	Colemanite .... $2CaO.3B_2O_3.5H_2O$	56° .... $\rho<v$ small.	$X=b$ .... $Z\wedge c=83.7°$.	Mon.	{010}perf. ...... {001}dist.	Colorless	H=4 G=2.42	Sol. in hot HCl. F=1.5.
1.590	1.602	1.595	Cuspidine .... $2CaO.Si(O,F_2)_2$	62° .... $\rho>v$.	$Y=b$ .... $Z\wedge c=5\frac{1}{2}°$ Disp. marked.	Mon. Spear-shaped.	{001}dist	Pale rose-red, colorless.	H=5 to 6 G=2.86 to 2.98.	Sol. in HNO_3. F=dif. Tw. pl.{100}.
1.562	1.632	1.595	Szmikite .... $MnO.SO_3.H_2O$	Near 90°	$Z=b$	Mon. (?) Fib. or plates.	One perf. (?)..	White, rose, chalky.	H=1.5 G=3.15	Sol. in HCl and H_2O. Infus.
1.577	1.616	1.596	Gilpinite .... $RO.UO_3.SO_3.4H_2O$ R=Cu,Fe,Na_2	Very large..... $\rho<v$ very strong.	$X=b$ .... Ext.{010}. Y to tw.=$5\frac{1}{2}°$. Disp. strong.	Mon. .... Laths{010} Elong. c.	....	Yellow, green.	H=2 to 2.5 G=3.9	Sol. in acid. Infus. Poly. tw. {100}. Faintly pleoc. in greenish yellow. Abs.: Z>Y>X.
1.597	1.612	1.597	Amesite .... $2(Mg,Fe)O.Al_2O_3.SiO_2.2H_2O$	Very small....	Z near c	Mon. Hex. plates.	{001}mic.	Pale bluish green.	H=2 to 3 G=2.77	A chlorite. Decpd. by HCl. Infus., but swells on heating. Mg:Fe=5:1.
1.595	1.625	1.60	Cebollite .... $5(Ca,Na_2)O.Al_2O_3.3SiO_2.2H_2O$	58°	....	Orth.(?) Fib. Arborescent.	....	White	H=5 G=2.96	Alteration of melilite. Gelat. F=5 to a clear glass.
1.590	1.638	1.602	Haidingerite .... $2CaO.As_2O_5.3H_2O$	58° .... Slight.	$X=b$ .... $Z=c$.	Orth. Crusts Tab.{010}.	{010} highly perf.	Colorless	H=1.5 to 2.5 G=2.85	Sol. in acid. F=2.5.
1.594	1.615	1.603	Fremontite .... $Na_2O.Al_2O_3.P_2O_5.H_2O$	Very large.....	$Z\wedge$tw. lamellae =29°.	Mon.(?)	....	....	H=5.5 G=3.04	A soda amblygonite. Poly. tw.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.579	1.633	1.603	Vivianite $3FeO.P_2O_5.8H_2O$	73° ± $\rho<v$ small.	$X=b$ $Z\wedge c=61.5°$ Disp. strong.	Mon.	{010}perf.	Colorless, green, blue.	$H=2$ $G=2.6$	Sol. in HCl. F=1.5. Colorless if fresh, but the colorless mineral on powdering rapidly changes to deep blue and becomes strongly pleochroic with X=dark cobalt-blue, Y=nearly colorless, Z=very pale olive-green to brownish.
1.606	1.610	1.606	Prochlorite $2FeO.2MgO.$ $Al_2O_3.2SiO_2.2H_2O.$	Very small. $\rho<v$ perc.	Z near *c*	Mon. Plates{001}. Vermicular.	{001}mic.	Green	Soft $G=2.9$	Chlorite group. Decpd. by hot conct. H_2SO_4. F=5 to 5.5. Pleoc.: X and Y=nearly colorless, Z=greenish or brownish.
B=0.02		1.606	Martinite $5CaO.2P_2O_5.1\frac{1}{2}H_2O$	Medium large.	$Y=b$ and bisects obtuse angle of rhombs. Z emerges from plates.	Mon(?). Rhombic tablets (65°).		Colorless	 $G=2.89$	Sol. in dilute acid. Infus.
1.595	1.634	1.606	Pectolite $Na_2O.4CaO.6SiO_2.$ $H_2O.$	60° $\rho>v$ slight.	$Z=b$ $Y\wedge a=$small.	Mon. Acic. *b*.	{100}{001}perf.	do.	$H=4.5$ to 5 $G=2.74$ to 2.88	Partly decpd. by HCl. F=2.
1.605	1.613	1.607	Corundophilite $11(Fe,Mg)O.4Al_2O_3.$ $6SiO_2.10H_2O$	Medium $\rho<v$ rather strong.	$X\wedge$cleav.$=8°$.	Mon.	{001}mic.	Green	Soft $G=2.9$	Chlorite group. Decpd. by H_2SO_4. F=dif. Pleoc.: X and Y=bright green, Z=nearly colorless.
1.612	1.616	1.612	Aphrosiderite $6(Fe,Mg)O.$ $2(Al,Fe)_2O_3.4SiO_2.$ $5H_2O$	Small	$Z=c$	Mon. Fib. and plates{001}.	do.	do.	Soft $G=2.96$	Chlorite group. Gelat. F=dif. Pleoc.: X and Y=olive green, Z=colorless.
1.602	1.649	1.613	Anapaite $2CaO.FeO.P_2O_5.$ $4H_2O$	53° ± $\rho>v$ perc.	On(100)15° to c	Tric. Elong. c. Radiating.	{101} {010}.	Greenish white.	$H=3.5$ $G=2.81$	Easily sol. in cold acid.

1.609	1.619	1.613	Stokesite. $CaO.SnO_2.3SiO_2.2H_2O$	70°. $\rho<v$.	Z=c. Y=b.	Orth. Pyramidal.	{110}perf. {010}imperf.	Colorless	H=6 G=3.19	
1.614	1.636	1.617	Calamine. $2ZnO.SiO_2.H_2O$	46°. $\rho>v$ strong.	X=b. Z=c.	Orth. Elong. c.	{110}perf. $\{10\bar{1}\}$less so.	do.	H=5 G=3.45	Gelat. F=6.
1.588	1.655	1.617	Cyanotrichite. $4CuO.Al_2O_3.SO_3.8H_2O$	82°. $\rho<v$ large.	Z=c.	Orth. Velvet-like. Needles c.		Bright blue.	G=2.74±	Sol. in acid. F=3. Strongly pleoc.: X=nearly colorless, Y=pale blue, Z=bright blue.
1.607	1.639	1.619	Chondrodite. $4MgO.2SiO_2.Mg(F,OH)_2$	80°. $\rho>v$ small.	X∧c=26°to30° Z=b. Disp.	Mon. Tab. {010}.	{001}poor.	Yellow, red, green.	H=6 G=3.1	Humite group. Gelat. Infus. Poly. tw. {001}. Pleoc.: X=yellow, Y and Z=nearly colorless.
B = very weak.		1.62	Torbernite. $CuO.2UO_3.P_2O_5.8H_2O$	Near 0. Disp. very strong.	Z=c.	Ps. tetrag. Sq. tablets {001}.		Emerald-green to grass-green.	H=2 to 2.5 G=3.5	Sol. in HNO_3. Abnormal blue to red interference colors.
1.61	1.65	1.62	Turquoise. $CuO.3Al_2O_3.2P_2O_5.9H_2O$	40°. $\rho<v$ strong.	On$\{1\bar{1}0\}$=12°. On other cleav.=5° and 34°. Disp. mkd.	Tric.	$\{1\bar{1}0\}$.	Sky-blue, bluish green.	H=5 G=2.84	Sol. in acid only after ignition. Infus. but turns brown b. b. Pleoc.: Colorless to pale-bluish.
1.610	1.625	1.62	Nontronite. $(Ca,Mg)O.Fe_2O_3.8SiO_2.7(\pm)H_2O$	Large.	X⊥cleav. Z// fib.	Orth.(?) Plates and fib.	One mic.	Yellowish green.	Soft. G=2.50	Gelat. Pleoc.: X=yellow-brown, Z=pale yellow. Data from somewhat altered mineral.
1.613	1.632	1.620	Pargasite. Silicate of Al, Fe, Mg, Ca, Na	59°(?). $\rho>v$.	Y=b. Z∧c=15° to 20°.	Mon. Pris. c.	{110}at 124°.		H=6	Amphibole group. Insol. in acid. F=easy. Pleoc.: Z=green, blue, or pink, Y and X=greenish.
1.619	1.627	1.620	Topaz. $2(AlF)O.SiO_2$	49° to 66°. $\rho>v$ dist.	X=a. Z=c.	Orth. Elon. c.	{001}perf.	Colorless, yellow, etc.	H=8 G=3.58	Slightly attacked by H_2SO_4. Infus.
1.620	1.654	1.620	Churchite. $3CaO.5Ce_2O_3.6P_2O_5.24H_2O$	0±. Slight.	Z⊥ plates	Orth.? Rectangular tablets with the long edge beveled.		Colorless	H=3 to 3.5 G=3.14	Sol. in acid. Infus.
1.61	1.71	1.62	Bisbeeite. $CuO.SiO_2.H_2O$	Small	Z//elong. Y(or X)⊥ laths	Orth. Very thin laths		White, cotton-like.	Soft.	Abs.: Z>X and Y.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.621	1.631	1.623	Uranopilite. $CaO.8UO_3.2SO_3.25H_2O(?)$	Medium large. $\rho<\upsilon$ extreme.	Ext. on {010} Y′∧ elong. 15°. X inclined to ⊥ laths. Disp. strong.	Tric.(?) Minute laths {010}, earthy.	....	Lemon-yellow.	Powder... G=3.75 to 3.97	Sol. in acid. Plates lying on {010} give sharp extinction in white light. Others give very abnormal interference colors.
1.622	1.631	1.624	Celestite. $SrO.SO_3$	51°. $\rho<\upsilon$.	X=*c*. Z=*a*.	Orth. Tab. {001}.	{001}perf. {110} nearly so, {010} less so.	Colorless.	H=3.5 G=3.96	Insol. in acids. F=3.
1.617	1.652	1.624	Humite. $6MgO.3SiO_2.Mg(F,OH)_2$	68°±. $\rho>\upsilon$ weak.	X=*b*. Z=*a*.	Orth. Tab. {010}.	{001}perf.	Colorless, yellow, brown.	H=6 G=3.1	Gelat. Infus. Pleoc.: X= golden yellow, Y and Z= nearly colorless. Poly. tw. {001}.
1.615	1.665	1.625	Destinezite. $2Fe_2O_3.P_2O_5.2SO_3.2H_2O$	Small. $\rho>\upsilon$ rather strong.	X inclined to ⊥ plates, Z to elong. 16°.	Tric.(?) Minute six-sided tablets.	....	White powder.	H=3 G=2.1	Sol. in HCl. F=dif.
1.614	1.637	1.625	Parahopeite. $3ZnO.P_2O_5.4H_2O$	Nearly 90°. $\rho<\upsilon$ perc.	Ext. {100} Y∧c=30°. Ext. {010}= 0 to 25°. X near *a*.	Tric. Tab. {100}.	{010}perf.	Colorless.	H=3.5 to 4 G=3.31	Sol. in HCl. F=easy. Tw. pl. {100} multiple and common.
B=weak	....	1.625	Georceixite. $(Ba,Ca,Ce)O.2Al_2O_3.P_2O_5.5H_2O$	....	....	Microcrystalline.	....	Brown, white, etc.	H=6 G=3.10	Alunite group.
1.616	1.649	1.626	Prehnite. $2CaO.Al_2O_3.3SiO_2.H_2O$	69°±. $\rho>\upsilon$ weak.	X=*a*. Z=*c*.	Orth. Elong. *c*.	{001}dist.	Green to gray.	H=6 G=2.9	Sol. in HCl slowly. F=2. Luster on {001} pearly.
B=0.02±	....	1.63±	Homilite (altered). $3(Ca,Fe)O.B_2O_3.2SiO_2.nH_2O(?)$	Medium large. $\rho<\upsilon$ very strong.	....	Ps. mon.	Imperf.	Yellow.	H=5 G=3	Altered homilite. Gelat. F=2.

1.631	1.640	1.632	Picropharmacolite...... $3(Ca,Mg)O.As_2O_5.6H_2O$	40°............ $\rho<v$ rather strong.	$Y=b$.......... $X\wedge c=37°\pm$.	Mon.......... Aggregates.	{010}{100}....	White.........	Soft....... G=2.58	
1.631	1.660	1.636	Schizolite............... $Na_2O.4(Ca,Mn)O.6SiO_2.H_2O$	47°............ $\rho<v$ rather strong.	Z near b....... $Y\wedge a=9°$.	Tric........... Pris. *b*.	{001}{100}perf	Light red altering to brown.	H=5 to 5.5 G=2.97 to 3.13	
1.636	1.648	1.637	Barite.................... $BaO.SO_3$	37½°.......... $\rho<v$ weak.	$X=c$.......... $Z=a$.	Orth. Tab. {001}.	{001}{110}perf. {010} imperf.	White.........	H=3 G=4.5	Insol. in acids. F=3. Tw. {110} lamellar.
1.64	1.66	1.64	Roeblingite............ $7CaO.2(Ca,Pb)O.5SiO_2.2SO_2.5H_2O$	Small.........	Elong.—......	....	....	Colorless......	H=3 G=3.43	Gelat. F=3.
1.640	1.657	1.640	Sarcolite............... $3(Ca,Na_2)O.Al_2O_3.3SiO_2$	Small......... $\rho>v$ strong.	....	Ps. tetrag..... Cubo-oct.	....	Reddish white, flesh-red.	H=6 G=2.7±	Gelat. F=2.5 to 3(?). Anom. biax.
1.633	1.657	1.642	Anthophyllite.......... $(Mg,Fe)O.SiO_2$	80°±.......... $\rho<v$.	$X=a$.......... $Z=c$.	Orth.......... Pris. *c*.	{110} perf. at 125° {010} good.	Gray, brown, green.	H=6 G=3.1.	Amphibole group. Insol. in acid. F=dif.
1.638	1.653	1.642	Sillimanite............. $Al_2O_3.SiO_2$	20°±.......... $\rho>v$ strong.	$X=b$.......... $Z=c$.	Orth. Prisms and needles // *c*.	{100} very perf.	Colorless, gray.	H=6 to 7 G=3.23	Insol. in acid. Infus. Data for artificial mineral.
1.636	1.654	1.644	Fairfieldite............. $2CaO.MnO.P_2O_5.2H_2O$	Very large..... $\rho>v$.	Ext. on{100}= 40° to *c*, on {010}=10°.	Tric. Pris., foliated, fib.	{010} highly perf., {100} good.	Nearly colorless. Luster on {010} pearly.	H=3.5 G=3.1	Sol. in acids. F=4.
B=0.01	....	....	Hellandite............. $2CaO.3(Al,Fe,Mn,Ce)_2O_3.4SiO_2.3H_2O$	80°............	$X=b$.......... $Z\wedge c=-43\frac{1}{2}°$.	Mon. Pris. *c*. Tab.{010}.	....	Nut-brown to brownish red	H=5.5 G=3.35 to 3.70	Sol. in HCl. F=easy. Tw. pl. {001} contact, {100} lamellar. Commonly altered; optical properties vary and finally the mineral becomes isotropic.
1.646	1.658	1.649	Mosandrite............. Contains Ti,Si,Ce,Ca, Na, Zr,O, etc.	74°±.......... $\rho>v$ strong.	$X\wedge c=2°\pm$.... $Y=b$.	Mon.(?)....... Elong. *c*.	{100} dist......	Reddish brown	H=4 G=3.0	Near johnstrupite. Sol. in HCl. F=3.
B=0.02±	....	1.65±	Homilite (altered)....... $3(Ca,Fe)O.B_2O_3.SiO_2+nH_2O(?)$	Near 0........ $\rho\gtreqless v$ very strong.	....	Ps. mon.......	Imperf........	Yellow.........	H=5 G=3.4	Alteration of homilite. Gelat. F=2.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.03	....	1.65±	Barrandite $(Al,Fe)_2O_3.P_2O_5.4H_2O$	Large ρ>υ strong.	Z=c	Orth. Fib. c.	....	Gray, etc.	H=4.5 G=2.6±	Sol. in acid. Fus.
1.635	1.670	1.651	Forsterite $2MgO.SiO_2$	85° ρ<υ.	X=b Y=c.	Orth. Equant	{010} and {001} dist.	Colorless	H=7 G=3.216	Olivine group. Data for pure artificial mineral. Gelat. Infus.
1.650	1.658	1.653	Enstatite $MgO.SiO_2$	31° ρ>υ.	Z=c Y=b.	Orth. Pris. c.	{110} perf. at 87°.	do	H=5 to 6 G=3.18	Pyroxene group. Data on pure artificial mineral. Insol. in acid. F=6. 2V, index, and B increase with FeO content.
1.640	1.680	1.653	Messelite $3(Ca,Fe)O.P_2O_5.2\frac{1}{2}H_2O$	Medium Slight.	Ext. on {100} 20° to c.	Tric. Tab.{100}.	One good	Colorless, brownish.	H=3 to 3.5 G=3	
B=0.029	....	1.654	Jadeite $Na_2O.Al_2O_3.4SiO_2$	72° ρ<υ weak.	Y=b Z∧c=33°±. Disp.	Mon. Fib. c.	{110} dist. at 88°. Parting {100}.	Green	H=6.5 G=3.4	Pyroxene. Insol. in acid. F=2.5. In sections colorless.
B=0.053	....	1.654	Dioptase $CuO.SiO_2.H_2O$	43°±	....	Trig.	{10$\bar{1}$1} perf.	Emerald-green	H=5 G=3.05	Gelat. Infus. Pleoc. faint. Abs.: X>Y and Z.
1.651	1.660	1.654	Clinoenstatite $MgO.SiO_2$	54° Slight.	X=b Z∧c=22°.	Mon. Elong. c.	{110} perf.	Colorless	G=3.28	Pyroxene group. Insol. in acid. Infus. Data on artificial mineral. Poly. tw {100} characteristic.
1.655	1.662	1.655	Uranochalcite UO_3,CuO,CaO,SO_3,H_2O	Small	Z=c	Matted. Fib. c	....	Grass-green to apple-green.	H=2 to 2.5	Sol. in acid. Abnormal interference colors. Faintly colored and pleoc.: X and Y very pale yellowish green, Z=pale-greenish yellow.
1.652	1.671	1.655	Euclase $2GlO.Al_2O_3.2SiO_2.H_2O$	50° ρ>υ.	Y=b X∧c=42.3°.	Mon. Elong. c.	{010} perf. {100} {001} poor.	Colorless, pale blue.	H=7.5 G=3.1	Insol. in acid. F=5.5.

1.649	1.714	1.656	Natrochalcite $Na_2O.4CuO.3SO_3.3H_2O$	37° $\rho<v$ strong.	$Y=b$ $Z\wedge c=-12°$. Disp. strong.	do.	{001}perf.	Emerald-green	H=4.5 G=2.33	Sol. in H_2O slowly. F=easy. Dispersion of bisectrices strong. $Z\wedge c$ for red is greater than for blue.
B=0.03		1.656	Chondrodite $4MgO.2SiO_2.Mg(F,OH)_2$	80°± $\rho>v$ weak.	$X\wedge c=27°\pm$ $Y=b$. Disp.	Mon.	{001}perf.	Colorless	H=6 G=3.1	Humite group. Gelat. Infus. Tw. pl.{001} poly. Pleoc.: X=Honey-colored, golden, or brown; Y and Z nearly colorless.
1.651	1.683	1.656	Reddingite $3MnO.P_2O_5.3H_2O$	41° $\rho>v$ strong.		Orth. Oct.	One dist.	Pink, violet, red-brown.	H=3 to 3.5 G=3.10	Sol. in acid. F=2.5 to 3.
1.640	1.695	1.658	Veszelyite $7(Zn,Cu)O.(P,As)_2O_5.9H_2O$	71° $\rho<v$ very strong.		Mon. or tric. Incrustations.		Greenish blue.	H=3.5 to 4 G=3.53	Fus. Pale greenish blue and nonpleoc. in section.
1.655	1.670	1.66	Salmonsite $Fe_2O_3.9MnO.4P_2O_5.14H_2O$	Very large. $\rho<v$ strong.	Z // fibers.	Orth. Massive	Two at 90° dist.	Yellowish.	H=4 G=2.88	Pleoc.: X=nearly colorless, Z= orange-yellow.
1.650	1.672	1.660	Triplite $3MnO.P_2O_5.MnF_2$	Very large. $\rho>v$ strong.	$Y=b$ $Z\wedge a=42°$.	Mon.	{100}perf. {010}poor.	Pale salmon.	H=4 to 4.5 G=3.79.	Sol. in acids. F=2.5. Data on mineral with 1.7 per cent FeO. Abs.: $X>Y\geqq Z$.
1.659	1.680	1.660	Sillimanite $Al_2O_3.SiO_2$	20° $\rho>v$ strong.	$X=b$ $Z=c$.	Orth. Acic. *c*.	{100}perf.	White.	H=6 G=3.23.	Insol. in acid. Infus. May be pleoc.
1.626	1.699	1.661	Erythrite $3CoO.As_2O_5.8H_2O$	90°± $\rho<v$ weak.	$X=b$ $Z\wedge c=31°$.	Mon. Laths {010} elong. *c*.	{010}highly perf.	Crimson to gray.	H=1.5 to 2.5 G=2.95.	Sol. in HCl. F=2. Strongly pleoc.: X=pale pinkish, Y=very pale violet, Z=red. Colors vary.
1.645	1.688	1.661	Leucosphenite $2Na_2O.BaO.2TiO_2.10SiO_2$	77° $\rho>v$ rather strong.	$Z=b$ $Y\wedge c=3°$.	Mon. Elong. *c*.	{010}dist.	White, gray-blue.	H=6.5 G=3.05.	F=dif. Tw. pl.{001}.
1.640	1.680	1.661	Forsterite $2MgO.SiO_2$	90°± $\rho<v$ slight.	$X=b$ $Z=a$.	Orth. Equant.	do.	Colorless, etc.	H=7 G=3.2.	Olivine group. Gelat. Infus.
1.658	1.671	1.662	Dickinsonite $3(Mn,Fe,Na_2)O.P_2O_5.\frac{1}{3}H_2O$	Med. $\rho>v$ strong.	$X=b$ Y near *c*.	Mon. Tab. Foliated{001}	{001}perf.	Olive-green, etc	H=3.5 to 4 G=3.34	Sol. in acids. F=2.5 to 3. Pleoc. in green. Abs. $X>Y\gg Z$.
1.629	1.727	1.662	Lindackerite $3NiO.6CuO.SO_3.2As_2O_5.7H_2O$	73° $\rho<v$ strong.	$X\wedge$elong. 26°. $Y=b$.	Mon.? Oblong rhombic tablets {010}. Fib.	{010}perf.	Apple-green.	H=2 to 2.5 G=2.0 to 2.5	F=2 to 3(?).

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.02±		1.665	Homilite (altered) $3(Ca,Fe)O.B_2O_3.2SiO_2+nH_2O(?)$	Small $\rho>v$ very strong.		Ps. mon.	Imperf.	Yellow	H=5 G=3.38	Gelat. F=2.
1.661	1.673	1.666	Johnstrupite Silicate of Ce, Ca, Na, etc., containing F and Ti.	70° $\rho>v$ strong.	$X\wedge c=2°$ $Y=b$.	Mon.	{100}dist.	Brownish green	H=4 G=3.29	Sol. in HCl. F=3. Poly. tw.{100}. In section colorless.
1.660	1.676	1.666	Spodumene $Li_2O.Al_2O_3.4SiO_2$	58°± $\rho<v$.	$Y=b$ $Z\wedge c=24°$.	Mon. Pris. c.	{110}perf. at 88° {010}parting. {100}parting rare.	White, yellow, green, violet, etc.	H=6.5 G=3.2	Pyroxene group. Insol. in acids. F=3.5. Abs.: X>Y>Z.
1.662	1.673	1.667	Boracite $6MgO.8B_2O_3.MgCl_2$	Very large		Orth. Ps. isomet.	{111}traces	White, etc.	H=7 G=2.95	Sol. in acid. F=2. Isomet. above 265° C.
1.665	1.681	1.668	Rinkite $Na_2O.22CaO.3Ce_2O_3.8(Zr,Ti)O_2.24SiO_2.16NaF$	43°± $\rho<v$ very strong.	$Y\wedge c=-7.5°$ $X=b$. Disp. dist.	Mon. Elong. c.	{100}dist.	Yellowish brown, straw-yellow.	H=5 G=3.46	Decpd. by dil. acids. Fus. Tw. pl.{100}poly. Abs.: Z>Y>X. Nearly colorless in section.
1.665	1.674	1.669	Enstatite $(Mg,Fe)O.SiO_2$	80° $\rho>v$ weak.	$X=a$. $Z=b$.	Orth. Pris. c.	{110} perf. at 88°.	Green	H=5.5 G=3.2	Pyroxene group. Data for mineral with 5 per cent FeO. Insol. in HCl. F=6. 2V, index, and B increase with iron.
B=0.04		1.670	Prolectite $2MgO.SiO_2.Mg(F,OH)_2$	2K=80°	$Z=b$. $X\wedge a=47°$.	Mon.	{001}poor		H=6 G=3.1	Humite group. Gelat. Infus. Poly. tw. {001} common.
B=0.014		1.67	Lotrite $2(Al,Fe)_2O_3.3(Ca,Mg)O.4SiO_2.2H_2O$	18°	$Z=b$. $Y\wedge$cleav. 28°.	Massive	Parallel to length perf.		H=7.5 G=3.23	
1.658	1.690	1.670	Clinohumite $8MgO.4SiO_2.Mg(F,OH)_2$	76° $\rho>v$ weak.	$Z=b$. $X\wedge c=9°\pm$. Disp. perc.	Mon.	{001}poor	Yellow to reddish brown.	H=6 G=3.1	Humite group. Gelat. Infus. Pleoc.: X=yellow, Y and Z=nearly colorless. Poly. tw.{001}.

1.662	1.691	1.671	Viridine $(Al, Fe, Mn)_2O_3.SiO_2$	71° $\rho<v$.	$X=a$ $Y=b$.	Orth	{001}good		H=6.5 G=3.22	Pleoc.: X=light yellow, Y=grass-green, Z=dark yellow. Contains 5 to 7 per cent Mn_2O_3.
1.670	1.689	1.671	Hinsdalite $2PbO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$	0 to 30°	$Z=c$	Ps. hex. Tab. {0001}. Rhombs.	{0001}perf.	White, gray	H=4.5 G=3.65	Alunite group. Insol. in HCl. Infus. Basal section divided into 6 segments and opt. pl. of each is ⊥ hex. edge.
1.664	1.694	1.671	Diopside $CaO.MgO.2SiO_2$	59° $\rho>v$ weak.	$Z \wedge c=38\frac{1}{3}°$ $Y=b$.	Mon. Pris. c.	{110} at 87° perf.	Colorless, etc.	H=5 to 6 G=3.28	Pyroxene group. Data on pure artificial mineral. Insol. in acid. Infus.
1.672	1.676	1.672	Fillowite $3(Mn,Fe,Na_2)O.P_2O_5.H_2O$	Small		Mon. Ps. rhomb.	{001} nearly perf.	Yellow, reddish brown, colorless.	H=4.5 G=3.43	Sol. in acid. F=1½.
1.665	1.682	1.673	Triplite $3MnO.P_2O_5.MnF_2$	Near 90° $\rho>v$ strong.	$Y=b$ $Z \wedge a=42°$.	Mon.	{100}perf. {010}perf.	Pale salmon	H=3.5 G=3.58	Sol. in acid. F=2.5. Data for mineral with percentages of FeO=4.95, CaO=3.18, MgO=0.58.
1.671	1.684	1.674	Natrophilite $Na_2O.2MnO.P_2O_5$	Large $\rho<v$ strong.	$Z=b$ $X=a$.	Orth	{001}perf. {010}good.	Deep wine-yellow.	H=4.5 to 5 G=3.41	Sol. in acid. F=2 to 2.5.
1.663	1.699	1.674	Spodiosite $3(Ca,Mg)O.P_2O_5$. Some CaF_2.	69°± $\rho>v$ rather strong.	Ext. on cleav. 38° to other cleav.	Tric.? Flattened prisms.	{010}dist. {001}indist.	Ash-gray, brown.	H=5 G=2.94(?)	Sol. in acid. F=dif.
1.665	1.684	1.674	Lawsonite $CaO.Al_2O_3.2SiO_2.2H_2O$	84° $\rho>v$ strong.	$X=a$ $Z=c$.	Orth Tab. {001}.	{010}perf. {001} rather perf. {110}less so.	Colorless, bluish.	H=8 G=3.09	Insol. in acid. F=4. Pleoc. in thick plates: X=blue, Y=yellowish, Z=colorless.
1.661	1.689	1.675	Liskeardite $3(Al,Fe)_2O_3.As_2O_5.16H_2O$	Near 90°	Z=fib.	Orth. Crusts. Fib.		White		
1.653	1.697	1.675	Ludlamite $7FeO.2P_2O_5.9H_2O$	82° $\rho>v$ small.	$Y=b$ $Z \wedge c=-67°$.	Mon. Tab. {001}.	{001}highly perf. {100}dist.	Bright green	H=3 to 4 G=3.72	Sol. in acid. F=2 to 2.5.
B=weak		1.676	Pharmacosiderite $3Fe_2O_3.2As_2O_5.13H_2O$	Large $\rho<v$ very strong.	Large ext. Disp. strong.	Mon.? Ps. isomet. Cubes, tetrah.	{100}imperf.	Olive-green, yellow-brown, etc.	H=2.5 G=3.0	Sol. in acids. F=1.5 to 2. Poly. tw.
1.669	1.702	1.678	Titan olivine $2(Mg,Fe)O.(Si,Ti)O_2$	62° $\rho<v$ dist.	$X=b$ $Z=a$.	Orth		Red, brown, dark red.	H=7 G=3.26	Sol. in acids. Infus. Pleoc. intense: Z and Y=bright yellow, X=deep reddish yellow.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.676	1.687	1.679	Lithiophilite $Li_2O.2(Mn,Fe)O.P_2O_5$	63° $\rho<v$ very strong.	X=*a* Z=*b*.	Orth. Elong. *c*.	{001}perf. {101}poor.	Pale pink, liver-brown.	H=5 G=3.5	Isomor. with triphylite. Data for mineral with 9.42 per cent FeO. Sol. in acid. F=1.5. Pleoc.: X=deep pink, Y=pale yellowish green, Z=pale pink. With increase of FeO β increases, 2V and B decrease.
1.678	1.683	1.68	Harstigite $24(Ca,Mn)O.3Al_2O_3.20SiO_2.7H_2O$	52° $\rho<v$ small.	X=*c* Z=*a*.	Orth. Pris. *c* with {010} {011}.		Colorless	H=5.5 G=3.05	After ignition easily sol. in HCl.
1.673	1.702	1.680	Diopside $CaO.MgO.2SiO_2$	59° $\rho>v$ weak.	Y=*b* Z∧*c*=38°±.	Mon. Pris. *c*.	{110} at 88°	Colorless, green, etc.	H=6 G=3.3	Pyroxene group. Insol. in acid. Infus.
1.662	1.699	1.680	Olivine $2(Mg,Fe)O.SiO_2$	Large $\rho<v$.	X=*b* Z=*a*.	Orth. Equant.	{010}dist. {100}less so.	Green, brownish, etc.	H=7 G=3.3	Olivine group. Gelat. F=dif. Habit characteristic. *Alters to serpentine and iddingsite.*
1.662	1.717	1.683	Koettigite $3ZnO.As_2O_5.8H_2O$	77° $\rho<v$ rather strong.	Z∧*c*=37° X=*b*.	Mon Fib. *c*.	{010}perf.	Carmine	H=2.5 to 3 G=3.1	Sol. in acid. F=3(?). Pale pink in section and nonpleoc.
B=0.012	....	1.685	Bronzite $(Mg,Fe)O.SiO_2$	90°	X=*a* Z=*b*.	Orth. Pris. *c*.	{110}perf. at 88°	Green, etc.	H=5.5 G=3.3	Pyroxene group. Insol. in HCl. F=6. Data for mineral with 10 per cent FeO.
1.681	1.695	1.685	Barylite $4BaO.Al_2O_3.7SiO_2$	65° $\rho>v$ weak.	Z=*a* X=*b*.	Orth. Pris. *c*. Tab. {100}.	{100}good	Colorless	H=7 G=4.03.	Insol. in acid. Infus. Greasy luster.
B=0.005	....	1.687	Riebeckite $Na_2O.Fe_2O_3.FeO.5SiO_2$	Very large. Disp. strong.	Y=*b* X∧c=1° to 8°.	Mon Pris. *c*.	{110} perf. at 124°.	Blue to black.	H=4 G=3.44.	Amphibole group. Insol. in acid. F=3? Pleoc.: X=deep-blue, Y=lighter blue, Z=yellow-green.
1.682	1.711	1.687	Rosenbuschite $Na_2O.3CaO.4(Si,Ti,Zr)O_2$	60°	X=*b* Z∧*c*=13°.	Mon. Elong. *b*.	{001}perf.	Orange or gray.	H=5 to 6 G=3.3	*Zircon pectolite.* Sol. in HCl. F=easy. Pleoc. faint in pale yellow. Abs.: Z>Y>X.

1.680	1.709	1.687	Aegirite-augite. Between augite and aegirite.	60°. $\rho>v$.	Y=*b*. X∧*c*=6° to 38°.	Mon. Pris. *c*.	{110}perf.at 88°	Green, yellow.	H=5 to 6. G=3.5	Pyroxene. Pleoc.: X=grass-green, Y=light green, Z=yellow to brownish.
1.679	1.710	1.688	Urbanite. $Na_2O.2FeO.(Ca,Mg)O.4SiO_2$	65°. $\rho<v$ perc.	Y=*b*. X∧*c*=20°.	do.	{110}perf.at 87°	Brownish black.	H=5 to 6. G=3.52	Pyroxene between diopside and aegirite. Slightly sol. in HCl. F=dif. to a black magnetic slag.
1.688	1.692	1.688	Triphylite. $Li_2O.2(Fe,Mn)O.P_2O_5$	0±. Disp. very strong.	Z=*b*.	Orth. Elong. *c*.	{001}perf. {010}dist.	Greenish or bluish.	H=5.	Isomor. with lithiophilite. Data for mineral with 26.58 per cent FeO. Sol. in acid. F=2. With increases of FeO β increases and X=*a*. B decreases and passes through 0 and mineral becomes opt.—.
1.682	1.710	1.690	Jeffersonite. $(Mn,Zn,Fe,Ca)O.SiO_2$	72°±. $\rho>v$ perc.	Y=*b*. Z∧*c*=54°.	Mon. Pris.	{110}perf.at 87°	Brown, green, black.	H=4.5. G=3.39	Pyroxene group. Data for mineral with percentages of MnO=7.4, ZnO=3.3, CaO=23.7, MgO=12.6. Insol. in acid. F=dif.
1.690	1.711	1.691	Pigeonite. $(Mg,Fe,Ca)O.SiO_2$	13° to 67°.	Y=*b*. Z∧*c*=46°±.	Mon. Pris. *c*.	{110}perf.at 88°	....	H=6. G=3.42	Pyroxene group. Insol. in acid. Infus. Pleoc.faint: X=yellowish green, Y=brownish red, Z=greenish white.
B=0.005	....	1.693	Pharmacosiderite. $3Fe_2O_3.2As_2O_5.13H_2O$	Large. $\rho<v$ very strong.	Ext. large. Y=*b*? Disp. strong.	Mon.? Ps. isomet. Cubic.	{100}imperf.	Green, brown, yellow.	H=2.5. G=2.9 to 3.0	Sol. in acid. F=1.5 to 2. Cubes divided into segments and these show poly. tw. Very abnormal interference colors.
B=0.012	....	1.695	Hiortdahlite. $(Na_2,Ca)O.FeO.2(Si,Zr)O_2$	Large.	Opt. pl.nearly {111}. Ext. on {100}=65°.	Tric. Tab.{100}.	Pris. at nearly 90° dist.	Bright yellow, yellow-brown.	H=5.5. G=3.27	Pyroxene group. Gelat. F=3(?). Pleoc.: X=colorless, Y=yellowish white, Z=wine-yellow.
1.695	1.733	1.698	Euchroite. $4CuO.As_2O_5.7H_2O$	29°. $\rho>v$ mod.	X=*b*. Z=*c*.	Orth. Pris. *c*.	{110}{011}tr.	Emerald to leek green.	H=3.5 to 4 G=3.39	Sol. in HNO_3. F=2 to 2.5. Bright bluish green in section and faintly or nonpleoc.
1.690	1.735	1.699	Neptunite. $(Na,K)_2O.(Fe,Mn)O.TiO_2.4SiO_2$	49°. $\rho<v$ extr.	Y=*b*. Z∧*c*=16°±. Disp.extr.	Mon. Pris. *c*.	{110}perf.at 80°	Black; in splinters deep red.	H=5 to 6. G=3.19	Insol. in HCl. F=2.5 to a black globule. Pleoc. strong: X=pale yellow, Y=yellowish red, Z=deep ocherous yellow to brownish red.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.025		1.70	Crocidolite. $Na_2O.2FeO.Fe_2O_3.6SiO_2$	90°±	Y=*b*. X∧*c*=15°±.	Mon. Fib. *c*.	{110}perf.at 60°	Lavender, blue, light green.	H=5 to 6. G=3.2	Amphibole group. Insol. in acid. F=3.5 with intumescence. Pleoc.: X=green to blue, Y=violet, Z=violet, green to colorless.
B=0.05		1.70	Gadolinite. $2GlO.FeO.2Y_2O_3.2SiO_2$	85°±. ρ<υ strong.	X=*b*. Z∧*c*=4° to 13°.	Mon. Pris.	Conch.	Black, brown.	H=7. G=4 to 4.5	Gelat. in part. Infus. Pale green and nonpleoc.
0.012		1.7±	Hainite. Na,Ca,Ce,Zr,Ti,Si,O, etc.	Large. ρ>υ.	Z=nearly ⊥ {010}. Ext. {100} nearly //. Ext. {010} =4°. Disp. very strong.	Tric. Acic. *c*.	{010} rather perf. {100} indist.	Wine or honey yellow to colorless.	H=5. G=3.18	Pyroxene group. Near hiortdahlite. Pleoc.: X=colorless, Y=faint yellow, Z=wine-yellow.
1.701	1.706	1.703	Serendibite. $10(Mg,Ca)O.5(Al,Fe)_2O_3.B_2O_3.6SiO_2$	Near 90°. ρ<υ strong.	Sections ⊥ tw. lamellae and nearly ⊥ Z have ext. of 35° to 40°.	Tric.? Six-sided plates.	None.	Sky to indigo blue.	H=6.5. G=3.42	Nearly insol. in acid. Infus. Pleoc.: Y and X=yellow to green or brownish yellow to colorless, Z=blue. Tw. poly. resembling plagioclase.
1.700	1.706	1.702	Zoisite. $4CaO.3Al_2O_3.6SiO_2.H_2O$	0 to 60°. ρ<υ strong or ρ>υ strong.	X=*c*. Y=*b*. X=*b*. Y=*c*.	Orth. Pris. *c*. Grains.	{010}very perf.	Gray, brown, greenish, rose.	H=6. G=3.3	Epidote group. Insol. in acid. Gelat. after ignition. F=3.5 Pleoc. faint. Abnormal interference colors.
1.678	1.733	1.703	Astrophyllite. $2(H,Na,K)_2O.4(Fe,Mn,Mg)O.TiO_2.4SiO_2$	75°±. ρ>υ.	X=*b*. Z=*a*.	Orth. Elong. Blades *c*.	{010}perf. {001}imperf.	Bronze-yellow.	H=3. G=3.4	Decpd. by HCl. F=2.5 to 3. Pleoc.: X=deep orange, Y=lemon-yellow, Z=orange.
1.698	1.723	1.704	Augite. $CaO.2(Mg,Fe)O.(Al,Fe)_2O_3.3SiO_2$	60°. ρ>υ.	Y=*b*. Z∧*c*=38° to 54°. Disp. dist.	Mon. Pris. *c*.	{110} perf. at 90°.	Green, etc.	H=6. G=3.4	Pyroxene group. Insol. in acid. F=about 3. Tw. pl. {100}{001}. Colorless in section.

1.700	1.724	1.705	Graftonite $3(Fe,Mn,Ca)O.P_2O_5$	55°± $\rho>v$ rather strong.	X=b. Disp. dist.	Mon.		Salmon-pink, darkens on exposure.	H=5 G=3.67	Readily sol. in acid. F=2. Colorless in section.
1.708	1.745	1.708	Strengite $Fe_2O_3.P_2O_5.4H_2O$	Small $\rho>v$ strong.	Z=c Y=a.	Orth. Fib. c.	{100}imperf.	Pink, blue, etc.	H=3 to 4. G=2.87	Compare scorodite. Sol. in HCl but not in H_2SO_4. F=2.5 to 3. Pleoc.: X=very pale rose, Y=colorless, Z=pale rose. Blue contains Mn.
1.708	1.718	1.711	Merwinite $3MgO.CaO.2SiO_2$	67° $\rho>v$ weak.	Z=b X∧c=36°.	Mon Grains.	{010}.	Colorless	H=6 G=3.15	Gelat. Fus. Poly. tw. very common. Tw. axis c, composition pl. {110} with angle 43° between sets. Less common tw. pl. and composition pl. {100}.
1.709	1.724	1.711	Brandtite $2CaO.MnO.As_2O_5.2H_2O$	23° $\rho<v$ rather strong.	X=b. Y∧c=8°.	Mon.? Pris. b, Tab. {001}.	{010}good	do	H=5 to 5.5 G=3.67	Sol. in HCl. F=2.5 to 3. Twinning common {100}.
1.714	1.719	1.715	Clinozoisite $4CaO.3Al_2O_3.6SiO_2$	Large $\rho<v$ strong.	Y=b. Z∧a=32°.	Mon. Elong. b.	{001}perf. {100}imperf.	Pale green, brown.	H=6.5. G=3.36	Epidote group. Insol. in acid. F=3. Abnormal interference colors. Fe_2O_3 =3 per cent.
1.70	1.74	1.72	Iddingsite $2Fe_2O_3.2SiO_2.3H_2O$	Large $\rho>v$ strong.		Pseudomorph after olivine.	Mic.	Reddish brown.	H=2.5 G=2.8	Decpd. by HCl. Infus. Pleoc. in brown and yellow.
1.712	1.731	1.721	Adelite $2MgO.2CaO.As_2O_5.H_2O$	Very large. $\rho<v$ perc.	Y=b. Z∧c=39°.	Mon. Tab. {001} or Pris. c.	None.	Gray.	H=5 G=3.75.	Sol. in HNO_3. F=easy.
1.702	1.750	1.722	Diaspore $Al_2O_3.H_2O$	84° $\rho<v$ weak.	Z=a. X=c.	Orth. Blades {010}. Elong. c.	{010}eminent. {210}less so.	Colorless, violet, etc.	H=7 G=3.4±	Insol. in acid. Infus. Luster pearly. Pleoc.: Reddish-brown to nearly colorless.
1.715	1.738	1.725	Homilite $3(Ca,Fe)O.B_2O_3.2SiO_2$	80° $\rho>v$ rather strong.	Y∧c=0± Z=b. Disp. dist.	Mon. Tab. {001}	Indist.	Black to dark brown.	H=5 G=3.36	Gelat. F=2. Pleoc.: X=bluish green, Y=deep brownish red, Z=deep smoky gray to brownish yellow.
B=0.01		1.725±	Roselite $3(Ca,Co,Mg)O.As_2O_5.2H_2O$	Medium $\rho<v$ strong.	X nearly ⊥ cleav. Ext. on cleav. Y∧tw. lamellae=3°.	Tric.	{100}perf.	Rose-red.	H=3.5 G=3.5 to 3.6	Sol. in acid. F=3. Faintly pleoc.: X and Y=pale rose-red, Z=nearly colorless. Lamellar twinning. Zonal growths.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.725	1.730	1.726	Triploidite $4(Mn,Fe)O.P_2O_5.H_2O$	Medium $\rho>v$ extreme.	X=*b*. Z∧*c*=0±. Disp. marked.	Mon. Pris.	{100}perf.	Yellowish to reddish brown.	H=5 G=3.43	Sol. in acid. F=1.5. Colorless in section.
1.713	1.746	1.726	Babingtonite $(Mn,Fe,Ca)O.Fe_2O_3.4SiO_2$	62° $\rho>v$ strong.	Opt. pl. nearly // {110} and {110}. Ext. on{100}=44° with *c*. Ext. on{010}=31°.	Tric. Pris. *c*.	{001}perf. {010}less so.	Greenish to brownish black.	H=5.5 to 6 G=3.35 to 3.40	Pyroxene group. Insol. in acid. F=3 to a black magnetic globule. Pleoc.: X=strong emerald-green or dark blue-green, Y=pale violet-brown or claret, Z=deep brown or pale brown.
1.724	1.734	1.729	Clinozoisite $4CaO.3Al_2O_3.6SiO_2.H_2O$	81° to 90° $\rho<v$ strong.	Y=*b*. X∧*c*=2°.	Mon. Elong. *b*.	{001}perf. {100}imperf.	Green, pale rose, etc.	H=6.5 G=3.36	Epidote group. Insol. in acid. F=3. Abnormal interference colors.
B=0.02	....	1.73	Piedmontite $4CaO.3(Al,Mn,Fe)_2O_3.6SiO_2.H_2O$	79°± $\rho>v$ strong.	Y=*b*. Z∧*a*=32°.	do	do	Reddish-black, red-brown.	H=6.5 G=3.40	Epidote group. Partly decpd. by HCl. F=about 3. Pleoc.: X=yellow, Y=violet, Z=red.
1.725	1.746	1.73	Augite (titaniferous) $CaO.2(Mg,Fe)O.(Al,Fe)_2O_3.3(Si,Ti)O_2$	33°	Z∧*c*=42°.	Mon. Pris. *c*.	{110}perf.at 87°	Black	H=6 G=3.39	Pyroxene group. Contains 4.84 per cent TiO_2. Pleoc.: X=reddish or pinkish brown with a violet shade, Y=reddish or pinkish brown with a violet shade, Z=pale bright yellow with a brownish shade.
1.726	1.737	1.730	Rhodonite $MnO.SiO_2$	Large	On{100}Z∧*c*=32°±. On{010}Z∧*c*=10°±.	Tric. Tab.{001}	{110}{$1\bar{1}0$}perf. {001}less so.	Red, etc.	H=6 G=3.67	Pyroxene group. Nearly insol. in acid. F=2.5. Data for fowlerite, a variety containing zinc.
B=0.01	....	1.73	Ottrelite $(Fe,Mn)O.Al_2O_3.3SiO_2.H_2O$	Variable $\rho>v$.	Y∧*b*=0±. Z∧*c*=25°±. Disp. strong.	Mon. or Tric.	{001}perf.	....	H=7 G=3.3	Brittle mica. Near chloritoid. Decpd. by H_2SO_4. Nearly infus. Pleoc.: X=olive-green, Y=blue, Z=yellow-green.

1.720	1.748	1.731	Jeffersonite $(Mn,Zn,Fe,Ca)O.SiO_2$	72° $\rho>\upsilon$ perc.	Y=b $Z\wedge c=54°$.	Mon. Pris.	{110}perf. at 87°	Brown, green, black.	H=4.5 G=3.5	Pyroxene group. A diopside with about 10 per cent each of FeO, MnO, and ZnO. Insol. in acid. F=4.
1.730	1.762	1.732	Strengite $Fe_2O_3.P_2O_5.4H_2O$	29° $\rho<\upsilon$ very strong.	X=a(?) Z=b(?).	Orth.	Two at 90°, good.	Pale, pink, etc.	H=3 to 4 G=2.87	Compare with scorodite. Sol. in HCl. F=2.5 to 3. Pleoc. faint in pale rose to colorless.
1.720	1.935	1.733	Molybdite $Fe_2O_3.3MoO_3.7\frac{1}{2}\pm H_2O$	28°± $\rho<\upsilon$ marked.	Y=a Z=c.	Orth. Fib. c.	{001}dist.	Sulphur-yellow.	H=1 to 2 G=4.50	Sol. in acids and decpd. by NH_4OH. F=easy. Pleoc.: X and Y=clear, Z=dirty gray to canary-yellow.
1.708	1.758	1.733	Adamite $4ZnO.As_2O_5.H_2O$	83°± $\rho<\upsilon$ strong.	Z=b X=a.	Orth. Elong. b.	{101}dist.	Colorless, etc.	H=3.5 G=4.34	Sol. in acid. F=3.
1.732	1.751	1.737	Hedenbergite $CaO.FeO.2SiO_2$	60° $\rho>\upsilon$ weak.	Y=b $Z\wedge c=48°$.	Mon. Pris. c.	{110}at 90° good	Green, etc.	H=6 G=3.7	Pyroxene group. Insol. in HCl. F=3.5 to 4. Pleoc.: X=pale green, Y=yellowish green, Z=dark green.
1.730	1.785	1.737	Antlerite $3CuO.SO_3.2H_2O$	35° $\rho<\upsilon$ very strong.	Y=c	Orth. Pris. c.		Light green	G=3.9	Pleoc. strong: X=pale yellowish green, Y=viridine-green, Z=viridine-green.
1.735	1.770	1.74	Molengraaffite $Na_2O, CaO, Al_2O_3, SiO_2, TiO_2$, etc.	28°	X=b $Z\wedge c$=very small. Y near a.	Mon. Pris.	{100}perf.	Yellow-gray		Pleoc. weak: X=light yellow, Y=colorless, Z=straw yellow. Tw. pl. {100} poly.
B=strong to weak.		1.74	Allanite $4(Ca, Fe)O.3(Al, Ce, Fe, Di)_2O_3.6SiO_2.H_2O$	Variable. Strong.	Y=b	Mon.	{001}{100} {110}imperf.	Brown, black.	H=6 G=3.5 to 4.2	Epidote group. Commonly opt.—. May gelat. F=3.
1.736	1.746	1.741	Staurolite $2FeO.5Al_2O_3.4SiO_2.H_2O$	88°± $\rho>\upsilon$ weak.	X=b Z=c.	Orth. Short prisms // c.	{010}dist. {110}imperf.	Yellow, red-brown, brownish black.	H=7 G=3.7	Slowly attacked by H_2SO_4. Infus. Cruciform tw. Pleoc. in yellows and reds. Abs.: X<Y<Z.
1.738	1.765	1.742	Scorodite $Fe_2O_3.As_2O_5.4H_2O$	Medium $\rho>\upsilon$ strong.	Z=c	Orth. Oct. Pris. c.	{110}imperf.	Leek-green to liver-brown.	H=3.5 to 4 G=3.1 to 3.3	Sol. in acid. F=easy. Data for mineral with 4.8 per cent P_2O_5.
B=0.003		1.745	Pyreneite $3CaO.Al_2O_3.3SiO_2$	56° $\rho<\upsilon$ strong.		Ps. isomet. Dodec.	None	Colorless, etc.	H=7 G=3.5	Insol. in acid. F=3. Birefracting grossularite.
1.745	1.830	1.745	Mixite $20CuO.Bi_2O_3.5As_2O_5.22H_2O$	0±	Z=c	Acic. c		Emerald-green	H=3 to 4 G=3.79	F=2. In section pale green and nonpleoc.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.747	1.757	1.748	Chrysoberyl $GlO.Al_2O_3$	45° $\rho>v$.	X=*a*. Y=*b*.	Orth. Tab. {100}, Ps. hex. from tw.	{011}dist. {100}imperf. {010}poor.	Green, yellow, red.	H=8.5 G=3.64	Insol. Infus. Tw. pl. {031}. Pleoc.: X=columbine-red, Y=orange-yellow, Z=emerald-green.
1.74	1.95	1.75±	Molybdite $Fe_2O_3.3MoO_3.7\frac{1}{2}\pm H_2O$	Small $\rho<v$ marked.	Y=*a*. Z=*c*.	Orth. Fib. *c*.	{001}dist.	Sulphur-yellow.	H=1 G=4.50	Sol. in acid and decpd. by NH_4OH. F=easy. Pleoc.: X and Y clear, Z=dirty gray to canary-yellow.
B=low		1.75	Pyroxmangite $(Mn,Fe)O.SiO_2$	30°	On{010}=5°. On {100} Z′∧c=45°.	Tric.	Pris.	Amber to black	H=5.5 to 6 G=3.80	Pyroxene group. Insol. in acid. F=3.
B=0.007 to 0.016		1.75	Chloritoid $(Fe,Mg)O.Al_2O_3.SiO_2.H_2O$	36° to 60° $\rho>v$ strong.	X=*b*. Z∧c=0 to 21° Disp. strong.	Mon. or tric. Plates{001}.	{001}perf. {443}imperf.	Gray, green.	H=6.5 G=3.55	A brittle mica. Decpd. by H_2SO_4. Nearly infus. Pleoc.: X=olive-green, Y=plum to indigo blue, Z=yellow to colorless.
1.743	1.788	1.75±	Lorenzenite $Na_2O.(Ti,Zr)O_2.2SiO_2$	39°	X=*c*. Z=*b*.	Orth. Pris. *c*.	{120}dist.		H=6 G=3.42	Insol. in HCl. F=easy. Abs.: X<Y>Z. In section colorless.
1.744	1.760	1.752	Daviesite Lead oxychloride.	Near 90° $\rho<v$ strong.	X=*b*. Z=*c*.	Orth. Minute prisms.		Colorless.		Sol. in HNO_3.
1.730	1.838	1.758	Azurite $3CuO.2CO_2.H_2O$	68° $\rho>v$ rather strong.	X=*b*. Z∧*c*=−13°. Disp. dist.	Mon.	{021}imperf.	Azure blue.	H=3.5 to 4 G=3.80	Sol. in acid. F=3. Pleoc. moderate in Prussian blue Abs.: X and Y<Z.
1.719	1.805	1.762	Dihydrite $5CuO.P_2O_5.2H_2O$	Near 90° $\rho<v$ strong.	X∧c=22°. Z near *b*.	Mon. or tric. Crystals and crusts. Fib. *b*.	{010}imperf.	Dark emerald-green.	H=4.5 to 5 G=4.0 to 4.4	Sol. in HCl. F=2. Pleoc.: X=bluish green, Y=yellowish green, Z=deep bluish green.
1.758	1.819	1.771±	Piedmontite $4CaO.3(Al,Mn,Fe)_2O_3.6SiO_2.H_2O$	56°	X∧c=−7°. Y=*b*. Disp. strong.	Mon. Crystals, fib. *b*.	{001}perf.	Red to black.	H=6 G=3.52	Epidote group. Gelat. after ignition. F=3. Pleoc. strong: X=orange to citron yellow, Y=amethyst to pink, Z=red.

1.765	1.797	1.774	Scorodite(?) $Fe_2O_3.As_2O_5.4H_2O$	62° $\rho > \upsilon$ rather strong.	X=*b*. Z=*c*.	Orth. Oct.	{120}imperf.	Leek-green, etc.	H=3.5 to 4 G=3.1 to 3.3	Sol. in HCl. F=2 to 2.5. Pleoc. in thick sections.
1.770	1.783	1.774	Barthite $3ZnO.CuO.3As_2O_5.2H_2O$	Mod. $\rho > \upsilon$ slight.		Mon.? Equant.	None?	Grass-green	H=3 G=4.19	Nearly colorless in section. Data for core of type material.
1.770	1.83	1.774	Taramellite $4BaO.FeO.2Fe_2O_3.10SiO_2$	40° $\rho > \upsilon$ strong.	X=*a*. Z=*c*.	Orth. Pris. *c*.	{100}perf.	Brown-red	H=5.5 G=3.92	Insol. F=very easy. Pleoc. intense: X and Y=pale flesh red with a touch of yellow, Z=nearly opaque.
1.758	1.795	1.776	Orientite $4CaO.2Mn_2O_3.5SiO_2.4H_2O$	67° $\rho < \upsilon$ very strong.	X=*a*. Z=*c*.	Orth. Pris. *c*. Tab. {010}.	{110}imperf.	Dark brown	H=4.8 G=3.05	Sol. in hot HCl. F=dif. Pleoc.: X=red-brown, Y=yellow, Z=brownish yellow.
1.778	1.801	1.78	Conichalcite $4(Cu,Ca)O.As_2O_5.1\frac{1}{2}H_2O$	Small	X=*c*. Y=*b*.	Orth. Fib.		Pistachio to emerald green.	H=4.5 G=4.15	Sol. in acid. F=2.5 to 3. In section pale green and nonpleochroic.
1.776	1.805	1.780	Caryinite $10(Pb,Mn,Ca,Mg)O.3As_2O_5$	41° $\rho > \upsilon$ slight.	Y=*a*. Z=*b*.	Orth.	{110}{010}.	Nut-brown	H=3 to 3.5 G=4.25	F=2.5. Not pleoc.
1.78	1.785	1.78±	Gadolinite $2GlO.FeO.2Y_2O_3.2SiO_2$	Medium $\rho < \upsilon$ strong.	Y=*b*. Z∧*c*=4° to 13°.	Mon.	Conch.	Black	H=7 G=4.3	Gelat. in part. Infus. Pale green in section and nonpleoc.
1.752	1.815	1.782	Shattuckite $2CuO.2SiO_2.H_2O$	Large	X=*b*. Z∧*c*=small.	Mon. Fib.		Green, blue		Pleoc.: X=very pale blue, Y=pale blue, Z=deep blue.
1.775	1.815	1.786	Beraunite $3Fe_2O_3.2P_2O_5.8H_2O$	Medium large. $\rho > \upsilon$ marked.	Z=*b*. Y∧*c*=1½°.	Mon. Tab. {100}.	{100}dist.	Reddish brown to hyacinth-red.	H=2 G=2.87 to 2.98	Variety eleonorite. Sol. in acid. F=3. Strongly pleoc.: X=nearly colorless, Y=pale flesh-color, Z=carnelian red. Tw. pl. {100}.
1.747	1.829	1.788±	Olivenite $4CuO.As_2O_5.H_2O$	Nearly 90° $\rho < \upsilon$ strong.	X=*b*. Z=*a*.	Orth. Acic. *c*.	Traces	Olive-green to dark yellow-brown.	H=3 G=4.3	Sol. in HCl. F=2 to 2.5. In part opt.−. Pale green in section and nonpleoc.
1.783	1.818	1.788	Lossenite $4PbO.9Fe_2O_3.6As_2O_5.4SO_3.33H_2O$	51° $\rho > \upsilon$ strong.	Y=*a*. Z=*c*.	Orth. Acute pyramids.		Brownish red	H=3 to 4	Sol. in acid. F=2 to 2.5.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.777	1.800	1.788	Retzian. Arsenate of Y, Mn, Ca, etc., and H_2O	Large. $\rho < v$ weak.	Y=*b*.	Orth. Pris. or tab.{010}.	None.	Chocolate-brown to chestnut-brown.	H=4 G=4.15	Sol. in acids. Infus. Pleoc.: X=colorless, Y=pale yellowish brown, Z=reddish brown.
1.786	1.837	1.788	Monazite. $(Ce,La,Di)_2O_3.P_2O_5$	14°. $\rho < v$ weak.	X=*b*. $Z \wedge c = 2° \pm$.	Mon.	{001}perf. {100}dist. {010}difficult	Red, brown.	H=5 G=5.1±	Difficultly sol. in HCl. Infus. Pleoc. faint: X=light-yellow, Y=dark-yellow, Z=greenish-yellow. Abs.: Y>X and Z. Tw. pl.{100}.
1.78	2.04±	1.79±	Molybdite. $Fe_2O_3.3MoO_3.$ $7\frac{1}{2} \pm H_2O$	Small. $\rho < v$ marked.	Y=*a*. Z=*c*.	Orth. Fib.*c*.	{001}dist.	Sulphur-yellow	H=1 to 2 G=4.50	Sol. in acid and decpd. by NH_4OH. F=easy. Pleoc.: X and Y=clear, Z=dirty gray to canary-yellow.
1.75	1.85	1.79	Uraconite. SO_3,U_2O_3,H_2O, etc.	Medium. $\rho < v$ strong.	Z=*c*. X=*a*.	Orth. Minute laths {100}, elong. *c*.		Lemon-yellow, earthy.	Soft	Sol. in acid.
B=0.020		1.79±	Ardennite. $8MnO.4Al_2O_3.V_2O_5.$ $8SiO_2.5H_2O$	36°±. $\rho > v$ very strong.	Y=*b*. Z=*a* or *c*.	Orth. Pris.*c*.	{010}perf. {110}dist. {001}parting.	Yellow to brown.	H=6 to 7 G=3.62	Nearly insol. in acid. F=2 to 2.5. Pleoc.: X=deep brownish-yellow, Y=golden-yellow, Z=pale-yellow.
1.784	1.812	1.793	Scorodite(?). $Fe_2O_3.As_2O_5.4H_2O$	70°±. $\rho > v$ rather strong.	X=*b*. Z=*c*.	Orth. Oct.	{120}imperf.	Leek-green, etc.	H=3.5 to 4 G=3.1 to 3.3	Sol. in HCl. F=2 to 2.5. Pleoc. in thick sections.
1.794	1.803	1.794	Arseniopleite. $9(Ca,Mn,Pb,Mg)O.$ $(Mn,Fe)_2O_3.$ $6As_2O_5.3H_2O$	0±.		Trig.? Massive		Brownish red.		Anom. biax. In section apricot-orange to blood-red.
1.780	1.815	1.795	Barthite. $3ZnO.CuO.3As_2O_5.$ $2H_2O$?	Near 90°. $\rho < v$ mod.		Mon. Equant.	None?.	Grass-green.	H=3 G=4.19	Yellowish green in section and faintly pleoc. Data for border of type material.

B=0.006		1.80	Enigmatite $2Na_2O.9FeO.(Al,Fe)_2O_3.12(Si,Ti)O_2$	32° $\rho<v$ (?).	Y near *b*. $Z\wedge c=45°$.	Tric.	{110} {1̄10} at 66° dist.	Black	H=5.5 G=3.80	Amphibole group. Insol. in acid. F=3. Pleoc. marked: X=clear red-brown, Y=deep chestnut-brown, Z=brownish black.
1.783	1.834	1.801	Flinkite $Mn_2O_3.4MnO.As_2O_5.4H_2O$	Large. Disp. slight.	Z=*a*. X=*b*.	Orth. Tab. {001}.	Not prominent	Greenish brown.	H=4 to 4.5 G=3.87	Readily sol. in acid. F=easy. Pleoc.: X=yellowish or brownish green, Y=yellowish green, Z=orange-brown.
B=0.015		1.8±	Ardennite $8MnO.4Al_2O_3.8SiO_2.V_2O_5.5H_2O$	0 to 50° $\rho>v$ very strong.	Z=*b*. X=*c*.	Orth	{010}perf. {110}dist.	Yellow, brown	H=6 to 7 G=6.3	Nearly insol. in acids. F=2 to 2.5. Pleoc.: X=deep brownish yellow, Y=golden yellow, Z=pale yellow.
1.772	1.863	1.810	Olivenite $4CuO.As_2O_5.H_2O$	82° $\rho<v$ strong.	X=*b*. Z=*a*.	Orth. Acic.	Traces	Olive-green	H=3 G=4.1 to 4.4	Sol. in HCl. F=2 to 2.5. In part opt.−. Pale green in section and non-pleoc.
1.808	1.830	1.810±	Warwickite $3(Mg,Fe)O.TiO_2.B_2O_3$	59°	X=*c*. Z=*a*.	Orth. Pris. *c*.	{100}perf.	Dark brownish to dull black.	H=3 to 4 G=3.4	Insol. in acid. F=5.5 Pleoc. strong: X=clear. yellowish brown, Y=reddish brown, Z=brown.
1.79	1.84	1.807	Leucochalcite $4CuO.As_2O_5.3H_2O$	Large $\rho<v$ strong.	Y=*c*.	Orth. Acic. *c*.		White silky		F=2 to 2.5 to a black glass.
1.817	1.821	1.818	Cerite $2(Ca,Fe)O.3Ce_2O_3.6SiO_2.3H_2O$	25° $\rho<v$ very strong.		Orth		Clove-brown, red-gray.	H=5.5 G=4.86 to 4.91	Gelat. Infus. Pleoc. faint: X and Y=nearly colorless, Z=pale reddish.
1.81	1.85	1.82±	Cornwallite $5CuO.As_2O_5.3H_2O$	Small	Elong.+or−.	Fib		Emerald-green.	H=4.5 G=4.16	F=2 to 2.5.
B=strong		High	Carminite $3PbO.5Fe_2O_3.6As_2O_5$			Orth. Acic.	// rhombic prisms.	Carmine to lilac.	H=2.5 G=4.10	Sol. in HNO_3. F=easy.
B=strong		1.84	Scorodite $Fe_2O_3.As_2O_5.4H_2O$	58° $\rho>v$ strong.	Z=*c*. X=*b*.	Orth. Oct. or pris.	{120}imperf.	Leek-green, brown, etc.	H=4 G=3.2	Sol. in HCl. F=2 to 2.5. Pleoc. faint: X=bluish green, Z=colorless to pink.
1.792	1.888	1.840	Lautarite $CaO.I_2O_5$	Near 90° $\rho>v$ perc.	Y=*b*. $X\wedge c=25°$.	Mon. Pris.	{011} rather perf.	Light wine-yellow to colorless.	H=4 G=4.59	Slightly sol. in H_2O. Sol. in HCl with evolution of Cl. F=1.5.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.830	1.885	1.840±	Dufrenite $2Fe_2O_3.P_2O_5.3H_2O$	0° to 90° Disp. extr.	Z=*b* Disp. extr.	Mon?. Fib.	{010}perf	Dull leek-green.	H=3.5 to 4 G=3.2 to 3.4	Sol. in acid. F=2.5. Pleoc. strong. When $\rho<v$: X=pale yellowish, Y=rather dark reddish brown, Z=dark reddish brown and Y // fibers. When $\rho>v$: X=bright green, Y=pale yellowish, Z=dark reddish brown and X // fibers.
1.85	2.02	1.85±	Ludwigite $3MgO.FeO.Fe_2O_3.B_2O_3$	Small	Z=*c*	Orth. Fib. *c*.		Blackish green	H=5 G=4.0	Sol. in acid. F=4.5. Pleoc.: X and Y=greenish, Z=reddish brown. Nearly opaque in all directions.
1.85	1.99	1.85	Magnesioludwigite $4MgO.B_2O_3.Fe_2O_3$	Very small $\rho>v$ extr.	Z=*c*	do		Dark green	H=5 G=4	Sol. in acid. F=4. Pleoc.: X and Y=bright green, Z=dark reddish brown.
1.845	1.878	1.852	Toernebohmite $3R_2O_3.4SiO_2.H_2O$ R=Ce, La, Di, Al.	26° $\rho<v$ rather strong.				Light green to olive.	H=4.5 G=4.94	Slowly sol. in hot conc. acid. Pleoc.: X=light rose to greenish yellow, Y=bluish green, Z=light rose.
B=0.07±		1.86±	Purpurite $(Mn,Fe)_2O_3.P_2O_5.H_2O$	Med.	X=*a*	Orth	{100} rather perf. {010} less so.	Deep red or purple.	H=4 to 4.5 G=3.4	Sol. in acid. F=easy. Pleoc. strong: X=dark brownish gray, Y=scarlet, Z=purple.
B=0.04±		1.865±	Ancylite $2Ce_2O_3.3SrO.7CO_2.5H_2O$	0±	Y=*c* Z=*b*.	Orth	{110}curved	Hair-brown, yellow-green, or orange.	H=4.5 G=3.95	Readily sol. in acid. Infus.
1.86	1.90	1.87	Synadelphite $(Al,Mn)_2O_3.5MnO.As_2O_5.5H_2O$	Small	$X\wedge c=45°$ Z=*b*.	Mon. Pris.		Brownish, black.	H=4.5 G=3.45 to 3.50	Sol. in HCl with evolution of Cl. F=2 (?). Feebly pleoc. in dark brown.
1.817	2.057	1.879	Uvanite $2UO_3.3V_2O_5.15H_2O$	52°		Orth	Two pinacoidal.	Brownish yellow.		Readily sol. in ammonium carbonate solution. Pleoc.: X=light brown to yellow, Y=dark brown, Z=greenish yellow.

1.87	1.93	1.88	Hemafibrite $6MnO.As_2O_5.5H_2O$	35° $\rho>v$.	$X=b$ $Z=c$.	Orth. Pris. fib.	{010}dist	Brownish to garnet-red, alters black.	H=3 G=3.6	Sol. in HCl with evolution of Cl. F=2(?). Red-brown in section and nonpleoc.
1.877	1.894	1.882	Anglesite $PbO.SO_3$	60° to 75° $\rho<v$ strong.	$X=c$ $Z=a$.	Orth	{001}{110}dist.	Colorless	H=3 G=6.3	Slowly sol. in HNO_3. F=1.5.
B=0.015		1.9±	Ardennite $8MnO.4Al_2O_3.8SiO_2.V_2O_5.5H_2O$	0° to 50° $\rho>v$ very strong.	$Z=b$ $X=c$.	Orth. Pris. c.	{010}perf{110} dist.	Yellow to brown.	H=6 to 7 G=3.62	Nearly insol. in acids. F=2 to 2.5. Pleoc.: X=deep brownish yellow, Y=golden yellow, Z=pale yellow.
(?)	(?)	(?)	Catoptrite $2SiO_2.Sb_2O_5.2(Al,Fe)_2O_3.14(Mn,Fe,Ca)O$	Small $\rho>v$.	$Y=b$ $Z \wedge$ trace of {100}=14° to 15°. Incl. disp. strong.	Mon. Tab. {010}.	{100}very perf.	Black. In splinters blood red. Luster metallic.	H=5.5 G=4.5	Not attacked by acid. Pleoc. strong in red brown to red yellow. Near manganostibiite and hematostibiite.
1.900	2.034	1.907±	Titanite $CaO.TiO_2.SiO_2$	27± $\rho>v$ marked.	$Y=b$ $Z \wedge c=51$.	Mon. Wedge-shaped, flattened {001}, etc.	{110} rather dist.	Yellow, brown, colorless, etc.	H=5 G=3.5	Sol. in H_2SO_4. F=3. Pleoc.: X=nearly colorless, Y=pale greenish, etc., Z=yellow, red, or pink.
1.910	1.945	1.91	Ganomalite $6PbO.4CaO.6SiO_2.H_2O$	Small		Tetrag.	{110}{001}dist.	Gray	H=3 G=5.74	Gelat. with HNO_3. F=3.2. Anom. biax.
B=0.01		1.915	Huegelite Vanadate of Pb, Zn, and H_2O	0 for red-orange $\rho<v$ extr.	Y near c Z nearly ⊥ laths. Disp. extr.	Mon. laths.		Orange-yellow, yellow-brown.	H=5	Crystals lying on lath face (nearly ⊥ X) show sharp, parallel extinction in white light but have abnormal green interference colors. Other sections give no extinction in white light but abnormal colors. Pleoc. faint: X=very pale greenish yellow, Y=pale orange.
1.871	2.01	1.92	Claudetite As_2O_3	58° $\rho<v$ strong.	$Y=b$ $Z \wedge c=5½°$.	Mon. Thin tablets {010}.	{010}perf	Colorless	H=2.5 G=3.85 to 4.15	Slightly sol. in hot H_2O. Volatile at 1. Tw. {100} penet.
1.885	1.956	1.920	Tsumebite $4PbO.2CuO.P_2O_5.nH_2O$	89° $\rho<v$ strong.		Orth. or mon. tab.			H=3.5 G=6	Faintly pleoc. in green. Abs.: Z>X.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.04±		1.92±	Purpurite $(Mn,Fe)_2O_3.P_2O_5.H_2O$	38°±	X=*a*	Orth.(?)	{100}rather perf., {010} less so.	Deep red or purple.	H=4 to 4.5 G=3.4	Sol. in acid. F=easy. Pleoc. intense: X=grayish, Y and Z deep blood red.
1.93±	1.97	1.93±	Zircon $ZrO_2.SiO_2$	10°±		Tetrag. Short prisms with pyramids.	{110}rare	Colorless, pink, brown, etc.	H=7.5 G=4.7	Insol. in acid. Infus. Abnormally biax. (See Uniaxial group, p. 190.)
1.915	2.03	1.935	Keilhauite $15CaO.(Al,Fe,Y)_2O_3.15TiO_2.16SiO_2$	50° $\rho>v$ strong.	Y=*b*	Mon.	{111}dist.	Brownish black	H=6.5 G=3.52 to 3.77	Insol. in acid. F=4 to 4.5.
1.963	1.966	1.963	Hyalotekite $9(Pb,Ba,Ca)O.B_2O_3.12SiO_2(?)$	Small $\rho<v$ strong.			Two at 90°	Colorless	H=5 to 5.5 G=3.80	Insol. F=3(?).
1.95	1.99	1.97	Bayldonite $4(Pb,Cu)O.As_2O_5.2H_2O$	Large $\rho<v$ strong(?).	X=*b*. Y∧elong. 45°±.	Mon.(?) Fib.*c*.		Grass-green	H=4.5 G=5.35	Sol. in HNO_3. F=2 to 3(?).
1.955	2.05	1.985	Uranosphaerite $Bi_2O_3.2UO_3.3H_2O$	Very large $\rho<v$ strong.	X=*a*. Z=*c*.	Orth.(?) Spherulites. Elong. *c*.	{100}perf.	Orange-yellow; brick-red.	H=2 to 3 G=6.36	On heating decrepitates.
B=very low		1.99	Agricolite $2Bi_2O_3.3SiO_2$	Large		Mon. Fib.		Yellow-brown.	H=3(?) G=6	Gelat. F=2.
B=0.015		2.0±	Ardennite $8MnO.4Al_2O_3.8SiO_2.V_2O_5.5H_2O$	0 to 50° $\rho>v$ very strong.	Z=*b*. X=*c*.	Orth.	{010}perf. {110}dist.	Yellow to brown.	H=6 to 7 G=3.65	Nearly insol. in acids. F=2 to 2.5. Pleoc.: X=deep brownish yellow, Y=golden yellow, Z=pale yellow.
2.00	2.02	2.01	Volborthite $6(Cu,Ca,Ba)O.V_2O_5.15H_2O$	Large to small. $\rho>v$ very strong.	Z nearly ⊥ plates. Disp. very strong.	Mon.(?) Six-sided tablets.	One perf.	Olive-green, citron-yellow.	H=3 G=3.55	F=1.5(?).

1.950	2.240	2.043	Sulphur S	69° $\rho<v$.	$X=a$ $Z=c$.	Orth. Pris. granular.	{001}{110}{111} imperf.	Yellow	H=2 G=2.06	Insol. in acids. F=1. Burns with a blue flame to fumes of SO_2. Pleoc. Tw. pl. {101}.
2.01	2.10	2.05	Calciovolborthite $4(Cu,Ca)O.V_2O_5.H_2O$	$68°_{Li}$, $83°_{Na}$, $89°_{Tl}$,	Disp. extr.	Mon.(?) Rosettes and hex. scales.	(?)	Yellow-green	H=3.5 G=3.5 to 3.9	F=1.5 to 3. Opt.— for violet light.
B=weak		2.087	Senarmontite Sb_2O_3			Ps. isomet. Oct.	{111}tr	Colorless	H=2 G=5.2	Sol. in HCl. F=1.5 volatile. Anom. biref.
			Georgiadesite $3PbO.3PbCl_2.As_2O_5$	Large	$Y=b$ $Z=c$.	Orth. Hex. outline.		White	H=3.5 G=7.1	Sol. in HNO_3. F=easy.
2.14	2.18	2.15	Atelestite $3Bi_2O_3.As_2O_5.2H_2O$	44° $\rho<v$ rather strong.		Mon	{001}indist.	Sulphur-yellow.	H=3 to 4.5 G=6.4	F=1.5.
2.12	2.31	2.17	Melanotekite $3PbO.2Fe_2O_3.3SiO_2$	67° $\rho<v$ rather strong.		Orth. Pris.	Two	Black	H=6.5 G=5.73	Decpd. by HNO_3. F=2 to 2.5 with intumescence. Pleoc. intense: X=nearly colorless, Y=pale reddish brown, Z=deep reddish brown.
2.00_{Li}	2.35_{Li}	2.18_{Li}	Tellurite TeO_2	90° $\rho<v$ mod.	$X=b$ $Z=c$.	Orth. Acic. or tab.{010}.	{010}very perf.	Colorless	H=2 G=5.90	May be opt.—. Fus. Flexible.
2.10	2.31	2.20	Kentrolite $3PbO.2Mn_2O_3.3SiO_2$	88° $\rho<v$ strong.	$X=a$ $Y=b$.	Orth. Pris.	{110}dist.	Dark reddish brown.	H=5 G=6.19	Sol. in HCl. F=2 to 2.5. Pleoc. in red. Abs.: Z>Y>X.
2.19	2.33	2.20	Tripuhyite $2FeO.Sb_2O_5$	Small $\rho<v$ very strong.		Microcrystalline.		Dull greenish yellow.	G=5.82	F=4 to 5(?).
1.94_{Na}	2.51_{Na}	2.20_{Na}	Lepidocrocite $Fe_2O_3.H_2O$	90° Disp. not strong.	$X=a$ $Y=c$.	Orth. Blades {100}, elong. c.	{100}very perf. {010}perf. {001}fair.	Red. Streak red.	H=4 G=4.09	Pleoc. strong: X=yellow, Y=deep red, Z=deeper red. Abs.: X<Y<Z.
2.200	2.260	2.217	Cotunnite $PbCl_2$	67°	$Z=a$ $X=c$.	Orth. Acic. a.	{001}perf.	White, yellowish, greenish.	Fragile G=5.84	Sol. in hot water. F=1.
2.17	2.32	2.22	Huebnerite $MnO.WO_3$	73°	$X=b$ $Z \wedge c=19°$.	Mon. Tab. {100}bladesc.	{010}very perf.	Brownish red.	H=5 to 5.5 G=6.7 to 7.3	Isomor. with wolframite. Decpd. by HCl. F=4. Pleoc. weak: X=nearly colorless, Y=yellow-brown, Z=green.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.24_{Li}	2.53_{Li}	2.24_{Li}	Manganite $Mn_2O_3.H_2O$	Small $\rho>\upsilon$ (?)very strong.	Y=b. Z=c.	Orth	{010}very perf. {110} perf.	Black	H=4 G=4.3	Sol. in HCl. Infus. Red-brown and nearly opaque in section. Abs. faint: X and Y<Z.
2.22	2.29	2.25	Manganotantalite $MnO.(Ta,Cb)_2O_5$	Large $\rho<\upsilon$ strong.	Y=a. Z=c.	do	{010}perf.	Dark reddish brown to black.	H=4.5 G=6.6±	Nearly insol. in acid. Infus. Yellow in section and nonpleoc. Indices for mineral with G=6.6.
2.19	2.34	2.25	Tantalite $(Fe,Mn)O.$ $(Ta, Cb)_2O_5$	Very large $\rho<\upsilon$ mod.	Y=a. Z=c.	do	do	Dark reddish brown.	H=4.5 G=6.5±	Nearly insol. in acid. Infus. Strongly pleochroic: X=very pale red, Z=blood red. Abs.: X≪Y<Z.
2.18	2.35	2.26	Descloizite $4(Pb,Zn,etc.)O.$ $V_2O_5.H_2O$	90°± $\rho>\upsilon$ rather strong.	X=c. Z=a.	Orth Short prisms.	None.	Cherry-red, brown, black.	H=3.5 G=5.9 to 6.2	F=1.5.
2.27	2.30	2.27	Raspite $PbO.WO_3$	0°±	Y=b. X∧c large.	Mon. Tab.{100}. Elong. b.	{100}perf.	Brownish yellow.	H=2.5	Decpd. by HCl. F=2.5 to 3. Abs.: X and Y>Z.
2.24	2.31	2.27	Mendipite $2PbO.PbCl_2$	90°± $\rho<\upsilon$ very strong.	Z=c.	Orth. Fib. c.	{110} highly perf. {100} {010} less perf.	White	H=2.5 to 3 G=7.0 to 7.1	Sol. in HNO_3. F=1.
2.26	2.34	2.29	Manganotantalite $(Fe,Mn)O.$ $(Cb,Ta)_2O_5$	Large $\rho<\upsilon$ strong.		Orth	{100} rather dist. {010} less so.	Nearly black	H=6 G=6±	Isomor. with columbite. Nearly insol. in acid. Infus. Streak dark red to black. Nearly opaque.
2.26	2.43	2.32	Tantalite $(Fe,Mn)O.$ $(Ta,Cb)_2O_5$	Large		do	{100} rather dist.	Black	H=6 G=6±	Nearly insol. in acid. Infus. Pleoc. strong: X=nearly colorless, Y=red-brown, Z=dark red-brown. Tw. pl. {021}.

2.26_{Li}	2.42_{Li}	2.32_{Li}	Wolframite. $(Fe,Mn)O.WO_3$	Large.		Mon. Tab.{100}.	{010}very perf.	Brownish black.	H=5 to 5.5 G=7.2 to 7.5	Isomor. with huebnerite and ferberite. Sol. in conct. H_2SO_4. F=3. Strongly pleoc. Abs.: $X>Y>Z$.
B=weak		2.33	Dysanalite. $7(Ca,Ce,Fe,Na_2)O.6TiO_2.Cb_2O_5$	90°±	$Z=b$. $X=a$.	Orth. Ps. isomet. Cubes.	{110} good. {100} less so.	Iron-black.	H=5 to 6 G=4.13	Infus. Pleoc. weak: X=light gray-green, Z=dark gray-green.
2.30_{Li}	2.40_{Li}	2.35_{Li}	Nadorite. $PbO.Sb_2O_3.PbCl_2$	Very large. $\rho>v$ strong.	$Y=b$. $Z=c$.	Orth. Tab.{100}. Pris. c.	{100}very perf.	Smoky brown, brown-yellow.	H=4 G=7.02	Sol. in HCl. F=1.5. Tw. pl. {010} crosses at about 90°.
2.31_{Li}	2.46_{Li}	2.36_{Li}	Wolframite. $(Fe,Mn)O.WO_3$	Large.		Mon. Tab.{100}.	{010}very perf.	Brownish black.	H=5 to 5.5 G=7.2 to 7.5.	Sol. in conct. H_2SO_4. F=3. Nearly opaque. Abs.: $X>Y>Z$.
2.28_{Li}	2.48_{Li}	2.36_{Li}	Brackebuschite. $3(Pb,Mn,Fe)O.V_2O_5.H_2O(?)$	Large. $\rho>v$ rather strong.		Mon. (?) Pris.		Black.		F=1.5 (?). Pleoc. very strong: X=nearly colorless, Y=clouded reddish brown, Z=clear reddish brown.
2.31_{Li}	2.66_{Li}	2.37_{Li}	Crocoite. $PbO.CrO_3$	54°. $\rho>v$ very strong.	$Y=b$. $Z\wedge c=-5\frac{1}{2}°$. Disp. very strong.	Mon.	{110} rather distinct.	Hyacinth-red.	H=2.3 to 3 G=6.0	F=1.5.
B=very weak.		2.38	Perofskite. $CaO.TiO_2$	90°±	$Z=a$. $Y=b$.	Orth. Ps. iso.	{100} poor.	Yellow, black, etc.	H=5.5 G=4.03	Decpd. by H_2SO_4. Infus. May be −. Complex interlaced tw.
2.38_{Li}	2.42_{Li}	2.39_{Li}	Pseudobrookite. $2Fe_2O_3.3TiO_2$	50°±	$Z=a$. $X=c$.	Orth. Tab. {100}.	{001} dist.	Dark brown to black.	H=6 G=4.4 to 5.0	Insol. in acid. Infus. Weakly pleoc. in reddish brown. Abs.: $X<Y>Z$.
2.374	2.457	2.404	Stibiotantalite. $Sb_2O_3.(Ta,Cb)_2O_5$	75°. $\rho<v$ strong.	$X=a$. $Z=c$.	Orth. Flattened {100}.	{100} very perf.		H=5 G=6.6 to 7.9	Isomor. with stibiocolumbite. Insol. except in **HF.** F=4. Data for mineral with G=6.82, Ta_2O_5=39 per cent. β and disp. increase with Cb, B and G decrease.
2.398	2.459	2.419	Stibiocolumbite. $Sb_2O_3.(Cb,Ta)_2O_5$	73°. $\rho<v$ strong.	$Y=b$. $Z=c$.	Orth. Tab. {100}.	do.		H=5 G=5.6 to 6.6	Insol. in acid. F=4. Data for mineral with G=6.30, Ta_2O_5=22.5 per cent. β and disp. increase with Cb, B and G decrease.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial positive group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.45_{Li}	2.51_{Li}	2.45_{Li}	Derbylite $6FeO.Sb_2O_3.5TiO_2$	Near 0		Orth. Pris. *c*.		Black	H=5 G=4.53	Insol. in acid. Infus. In section dark brown and non-pleoc.
2.37	2.65	2.5	Montroydite HgO	Large	Y ⊥ cleav.(?) Z=elong.	Orth. Pris.	{010} very perf.	Deep red, orange, brown.	H=2 to 3	Sol. in acid. Volatile.
2.583	2.741	2.586	Brookite TiO_2	$30°_{Na}$ 0 for yellow-green. Disp. very strong.	$X_r=b$ $X_{bl}=c$. $Z=a$.	Orth.	{110} indist.	Brown, black.	H=6 G=3.9	Insol. even in HF. Infus. Pleoc. weak.
2.51_{Li}	2.71_{Li}	2.61_{Li}	Massicot PbO	90°± Disp. strong.	$Y=a$?	Orth. Tab. {100}.	{100} perf.	Yellow	Soft G=9.29	Sol. in acid. F=1.5. Commonly bordered by litharge. Pleoc.: Y=light sulphur-yellow, Z=deep yellow. Opt.— for blue.
B = extreme.		$>2.72_{Li}$	Orpiment As_2S_3	2E=70° $\rho>v$ strong.	$X=b$. $Z=a$.	Mon. Foliated.	{010} highly perf.	Lemon-yellow	H=2 G=3.4	Sol. in H_2SO_4. F=1. Volatile. Luster on {010} pearly.
2.74	B = extreme.	$>2.72_{Li}$	Kermesite $Sb_2O_3.2Sb_2S_3$.	Small (?)	Elong.+	Mon. Pris.	{100} perf.	Cherry-red	H=1 to 1.5 G=4.5	F=1. Volatile.
B=very strong.		$>2.72_{Li}$	Miargyrite $Ag_2S.Sb_2S_3$	Med.		Mon.	{010} tr.	Iron black, Streak cherry-red.	H=2 to 2.5 G=5.2	Decpd. by HNO_2. F=1. In section blood-red.
>2.72	B = extreme.	$>2.72_{Li}$	Lorandite $Tl_2S.As_2S_3$		Z // elong.	Mon.	{100} perf.	Cochineal-red.	H=2 to 2.5 G=5.53	Sol. in HNO_3 with separation of S. F=1. Deep red in powder.
		Extreme	Pyrostilpnite $3Ag_2S.Sb_2S_3$		Ext. on {010}=8° to 11°	Mon. or tric.	{010} perf.	Hyacinth-red.	H=2 G=4.2	F=1. Tw. pl. {100}. Absorption.

Biaxial negative group.

[The minerals of this group are chiefly orthorhombic, monoclinic, or triclinic.]

1.394	1.398	1.396	Mirabilite $Na_2O.SO_3.10H_2O$	76° $\rho<v$.	X=*b* or Y=*b* $Z \wedge c=30°$. Disp. strong.	Mon. Near pyroxene.	{100} perf. {001}{010} tr.	White	H=2 G=1.481	Sol. in H_2O. F=1.5. Effloresces rapidly.
1.407	1.415	1.414	Thomsenolite $NaF.CaF_2.AlF_3.H_2O$	50° $\rho<v$ weak.	$X \wedge c=-52°$ Z=*b*.	Mon. Cubic.	{001} perf. {110} less so.	Colorless	H=2 G=2.98	Decpd. by H_2SO_4. F=1.5. Alteration of cryolite.
1.405	1.440	1.425	Natron $Na_2O.CO_2.10H_2O$	71° $\rho>v$ perc.	X=*b*.	Mon.	{100} good. {010} imperf.	White	H=1 G=1.46	Very sol. in H_2O. F=1. Rapidly loses H_2O on exposure to air.
1.440	1.453	1.452	Lecontite $(Na,NH_4,K)_2O.SO_3.2H_2O$	40° $\rho<v$ rather strong.		Orth. Pris.		Colorless	H=2 to 2.5	Sol. in H_2O. F=1.
1.430	1.458	1.452	Kalinite $K_2O.Al_2O_3.4SO_3.24H_2O$	52° Disp. weak.	Z=*b*. $Y \wedge c=13°$.	Mon.(?) Fib. *c*.		White	H=2 to 2.5 G=1.75	Sol. in H_2O. F=1.
1.448	1.456	1.454	Gearksutite $CaF_2.Al(F,OH)_3.H_2O$	Medium	X=*b*. $Y \wedge c=$ very large.	Mon. Needles *c*. Powder.		White, chalky	H=2 G=2.77	Sol. in acid. F=1.5 to 2.
1.435	1.459	1.455	Wattevillite $Na_2O.CaO.2SO_3.4H_2O$	48° Disp. slight.		Mon. Hairlike.		Colorless	G=1.81	Sol. in HCl F=1.5 to 2.
1.433	1.461	1.455	Epsomite $MgO.SO_3.7H_2O$	52° $\rho<v$ weak.	X=*a*. Z=*b*.	Orth. Elong. *c*.	{010} very perf. {011} less perf.	White	H=2 G=1.68	Sol. in H_2O. Tastes bitter and salty. F=1.
1.340	1.459	1.456	Sassolite $B_2O_3.3H_2O$	7°	X nearly ⊥(001). Ax.pl. nearly // to *b*.	Tric. Tab. {001}.	{001} perf.	White, pearly.	H=1 G=1.48	Sol. in H_2O. Tastes acidulous, saline, and bitter. F=0.5.
1.432	1.458	1.457	Mendozite $Na_2O.Al_2O_3.4SO_3.22H_2O$	Very small. Disp. slight.	Elong. −	Mon.(?) Fib.		White	H=3 G=1.88	Soda alum. Sol. in H_2O. F=1.
1.449	1.463	1.461	Mendozite $Na_2O.Al_2O_3.4SO_3.22H_2O$	56° Disp. slight.	X=*b*. $Y \wedge c=30°$.	Mon. Laths {100}, elong. *c*.	{010} perf.	do.	H=3 G=1.73	Artificial. Sol. in H_2O. F=1. Alters in air to tamarugite.
1.462	1.471	1.470	Paraluminite $2Al_2O_3.SO_3.15H_2O$	Small	X=elong.	Massive Fib.		White, chalky	Soft.	

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.447	1.472	1.470	Borax $Na_2O.2B_2O_3.10H_2O$	39° $\rho>v$ strong.	X=*b* $Z\wedge c=-56.9°$. Disp. strong.	Mon.	{100} perf. {110} less perf.	White.	H=2 G=1.70	Very sol. in H_2O. F=1 to 1.5. Tw. pl. {100}.
B=0.001 to 0.008	....	1.474	Gmelinite $(Na_2,Ca)O.Al_2O_3.4SiO_2.6H_2O$	Small	....	Ps. trig.	{10$\bar{1}$0} easy	do.	H=4.5 G=2.1	Zeolite group. (See Uniaxial group, p. 192.) Decpd. by acid. F=3. Tw. axis *c*.
1.461	1.485	1.478	Creedite $CaO.2CaF_2.2Al(F,OH)_3.SO_3.2H_2O$	63° $\rho>v$ slight.	$Z\wedge c=41°$. Y=*b*.	Mon. Pris. *c*. Rhombic cross section.	{100} perf.	Colorless.	H=3.5 G=2.73	Sol. in acid. F=dif. with intumescence.
1.457	1.484	1.480	Goslarite $ZnO.SO_3.7H_2O$	46° $\rho<v$ weak.	X=*b*. Z=*a*.	Orth. Acic. *c*.	{010} perf.	Colorless, yellowish, bluish, etc.	H=2 G=2.2	Sol. in H_2O. Taste astringent. Infus. Alters on exposure to dry air.
1.476	1.483	1.480	Pickeringite $MgO.Al_2O_3.4SO_3.22\pm H_2O$	Medium	Y=*b*. $Z\wedge c=37°$.	Mon. Fib.	....	Colorless, yellow, reddish.	H=1 G=1.85	Sol. in H_2O. F=easy. Tastes astringent.
1.476	1.480	1.48	Ptilolite $(Ca,K_2,Na_2)O.Al_2O_3.10SiO_2.5H_2O$	....	X=*c*. Y=*a*.	....	Orth. Slender laths Elong. *c*. Flattened {100}.	Colorless, white.	H=5	Zeolite group. Insol. in acid. F=4 to 5. Cotton-like aggregates.
1.391	1.486	1.481	Darapskite $3Na_2O.N_2O_5.2SO_3.2H_2O$	26° $\rho>v$ rather strong.	X=*b*. $Z\wedge c=12°$.	Mon.?	{100}{010}perf	Colorless.	H=2.3 G=2.20	Sol. in H_2O. F=1(?). Poly. tw. {100} similar to those of plagioclase.
1.478	1.482	1.482	Apjohnite $MnO.Al_2O_3.4SO_3.22\pm H_2O$	Rather small.	Y=*b*. $Z\wedge c=29°$.	Mon. Fib. *c*.	....	White, silky.	H=1.5 G=1.78 to 2.3	Sol. in H_2O. Infus. Tend to lie on {010} and {100}.
B=strong	....	1.482	Kalicinite $K_2O.2CO_2.H_2O$	....	Y=*b*. $X\wedge c=30°$.	Mon. Elong. *b*.	{100}{001}{101}	White.	.... G=2.16	Sol. in H_2O. F=easy.

1.477	1.489	1.483	Bieberite $CoO.SO_3.7H_2O$	Near 90° Disp. slight.	Z=*b*	Mon.(?)		Carmine	H=2 G=1.96	Sol. in H_2O. F=easy. Decpd. to the pentahydrate on exposure to air.
1.483	1.490	1.487	Leonite $K_2O.MgO.2SO_3.4H_2O$	86° $\rho<v$.	Y=*b* $Z \wedge c$=small.	Mon.		Colorless, etc.	H=3 G=2.25	Sol. in H_2O. F=easy.
B=0.001		1.487	Analcite $Na_2O.Al_2O_3.4SiO_2.2H_2O$	Very small		Ps. isomet. Trapezohedrons.	{100}imperf.	Colorless	H=5 G=2.25	Decpd. by HCl. F=2.5. Tw. grating. (See isotropic group, p. 172.)
1.485	1.489	1.488	Vanthoffite $3Na_2O.MgO.4SO_3$	84°± $\rho<v$.		Mon.(?)		do.	H=4 G=2.69	Sol. in H_2O. Fus.
1.486	1.489	1.488	Bloedite $Na_2O.MgO.2SO_3.4H_2O$	71° $\rho<v$ strong.	Y=*b* $X \wedge c$=41.1°	Mon. Tab.{001}. Simulates quartz.	None	Colorless, etc.	H=3 G=2.23	Sol. in H_2O. F=1.5.
1.467	1.492	1.489	Morenosite $NiO.SO_3.7H_2O$	42° $\rho>v$ large.	X=*b* Z=*a*.	Orth. Acic. *c*.	{010}perf.	Apple-green, etc.	H=2 G=2.00	Sol. in H_2O. Tastes astringent. Infus.
1.484	1.495	1.49	Stellerite $CaO.Al_2O_3.7SiO_2.7H_2O$	44° $\rho<v$.	X=*c* Z=*a*.	Orth. Tab.	{010}highly perf. {100} less so.	Light flesh-red	H=4 G=2.12	Zeolite group.
B=0.005		1.49	Halotrichite $FeO.Al_2O_3.4SO_3.24H_2O$		$Z \wedge c$=38°	Mon. Fib. *c*.		Colorless	H=2 G=1.89 to 2.04	Near alunogen. Sol. in H_2O. F=4.5 to 5. Tastes astringent.
1.412	1.540	1.492	Trona $3Na_2O.4CO_2.5H_2O$	72° $\rho<v$ rather strong.	X=*b* $Z \wedge c$=83°.	Mon. Elong. *b*.	{100}perf.	White, gray	H=3 G=2.13	Sol. in H_2O. F=1.5.
1.485	1.500	1.495	Epidesmine $(Ca,Na_2,K_2)O.Al_2O_3.6SiO_2.6H_2O$	40°	X=*c* Y=*a*.	Orth.	{100}perf. {010}less so.		G=2.16	Zeolite group. Gelat. Fuses with intumescence to a white enamel.
1.465	1.504	1.498	Nitrocalcite $CaO.N_2O_5.nH_2O$	50° Disp. slight.	X⊥cleav.	Silky tufts	One perf.	Colorless	Soft.	Very hygroscopic. F=easy.
1.494	1.500	1.498	Stilbite $(Ca,Na_2)O.Al_2O_3.6SiO_2.5H_2O$	33°±	Y=*b* $X \wedge a$=5°.	Mon. Acic. *a*.	{010}perf. {001}tr.	White, etc.	H=4 G=2.2	Zeolite. Decpd. by HCl. F=3. Tw. pl. {001} cruciform penet.
1.418	1.543	1.500	Nitroglauberite $5Na_2O.3N_2O_5.2SO_3.3H_2O$	60° $\rho<v$ rather strong.	X // elong. Y ⊥ laths.	Orth. Stout laths.		Colorless		

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.015		1.501	Didymolite $2CaO.3Al_2O_3.9SiO_2$	81° $\rho>v$.	$Y=b$ $X\wedge c=40°$.	Mon.	{010}{110}fair	Dark gray	H=5 G=2.71	Insol. in acid. F=dif. Tw. pl. {110} universal, {010} less common.
1.412	1.526	1.501	Nesquehonite $MgO.CO_2.3H_2O$	53° $\rho<v$ small.	$X=a$. $Z=b$.	Orth. Elong.*c*.	{110}perf. {001}imperf.	Colorless	H=2.5 G=1.84	Sol. in cold dilute HCl. Infus.
1.490	1.511	1.502±	Antigorite $3MgO.3SiO_2.2H_2O$	Large	$Z=b$. $X=c$.	Orth. Fib.		Green	H=4 to 5 G=2.6±	Serpentine. Decpd. by HCl. F=dif. Faintly pleoc.
1.334	1.506	1.505	Niter $K_2O.N_2O_5$	7° $\rho<v$ strong.	$X=c$. $Z=b$.	Orth. Equant or elong. *c*.	{011}perf. {010}{110}imperf.	Colorless	H=2 G=2.1	Sol. in H_2O. Tastes saline. F=1.
1.494	1.516	1.505	Kainite $MgO.SO_3.KCl.3H_2O$	85° $\rho>v$ small.	$Y=b$. $X\wedge c=-8°$. Disp. dist.	Mon. Tab. {001}.	{100}very dist. {110}dist.	do	H=3 G=2.13	Sol. in H_2O. F=1.5 to 2.
1.420	1.524	1.506	Thermonatrite $Na_2O.CO_2.H_2O$	48° $\rho<v$ weak.		Orth. Flat {001} or {100}.	{010}dif.	White	H=1.5 G=1.55	Sol. in H_2O. F=1.5.
1.344	1.506	1.506	Nitromagnesite $MgO.N_2O_5.nH_2O$	5° $\rho<v$ perc.				Colorless		Sol. in H_2O. Tastes bitter. F=easy.
B=0.011		1.506	Parasepiolite $2MgO.3SiO_2.4H_2O$	50°	Z=elong.	Orth. Fib.		White	Soft.	α sepiolite. Separates gelat. SiO_2 in acid.
1.495	1.514	1.508	Manganese chalcanthite. $MnO.SO_3.5H_2O$	Med. large $\rho>v$.		Tric.		Pale pink	H=2 to 3 G=2.10	Sol. in H_2O. F=3. Near chalcanthite.
1.502	1.512	1.510	Epistilbite $CaO.Al_2O_3.6SiO_2.5H_2O$	44° $\rho<v$ strong.	$Y=b$. $Z\wedge c=9°$.	Mon. Elong.*c*.	{010}perf.	Colorless	H=4 G=2.25	Zeolite. Decpd. by acid. F=3.
1.495	1.520	1.51	Inyoite $2CaO.3B_2O_3.13H_2O$	70° $\rho<v$ slight.	$Y=b$. X oblique to *c*.	Mon. Rhombic tablets {001}.	{001}good	do	H=2 G=1.87	Easily sol. in acid. B. b. decrepitates and fuses with much intumescence. Alters to meyerhofferite.

1.49	1.521	1.510	Uranospathite $CaO.2UO_3.P_2O_5.nH_2O$	69°	X=*c*	Orth Ps. tetrag.	{001}perf. {100}good.	Yellow to pale green.	G=2.50	Pleoc.: X=pale yellow, Y and Z=deep yellow. Becomes uniaxial in a desiccator.
1.512	1.515	1.514	Okenite $CaO.2SiO_2.2H_2O$	Large	Z=*c*	Orth. Fib. *c*		White, etc	H=5 G=2.17 to 2.36	Zeolite group. Gelat. F=2.5.
1.470	1.516	1.516	Leverrierite $Al_2O_3.3\pm SiO_2.3\pm H_2O$	0°±	X=*c*	Mon.(?) Plates{001}.	{001}mic	Colorless, green, yellow, brown.	H=1.5 G=2.6	Infus. On standing in oils β increases to 1.60. (See p. 193.)
1.444	1.523	1.516	Gaylussite $Na_2O.CaO.2CO_2.5H_2O$	34° $\rho<\upsilon$ strong.	X=*b* $Z\wedge c=-14°$. Disp. large.	Mon. Elong. *a*	{110}perf. {001}imperf.	Colorless	H=2 to 3 G=1.94	Slightly sol. in H_2O. Sol. in acids. F=1.5.
1.500	1.518	1.517	Syngenite $K_2O.CaO.2SO_3.H_2O$	27° $\rho<\upsilon$ very strong.	Z=*b* $Y\wedge c=-2.3°$.	Mon. Laths{100}. Elong. *c*.	{110}{100}perf.	White	H=2.5 G=2.60	Partly sol. in H_2O. F=1.5 to 2. Tw. pl. {100} common.
1.512	1.519	1.519	Scolecite $CaO.Al_2O_3.3SiO_2.3H_2O$	36°± $\rho<\upsilon$ strong.	Z=*b* $X\wedge c=17°$.	Mon. Elong. *c*	{110}perf.	do	H=5 G=2.3	Zeolite. Gelat. F=2.
B=slight.		1.52	Chlorocalcite $KCl.CaCl_2$			Cubes	Cubic		H=2.5 to 3	Strongly hygroscopic. Twinned.
1.520	1.528	1.52	Searlesite $Na_2O.B_2O_3.4SiO_2.2H_2O$	Very large	X=*b* Ext. very large.	Mon.? Spherulites.		White	Soft	Sol. in acid. Appreciably sol. in H_2O. F=easy.
1.519	1.529	1.52	Sepiolite $2MgO.3SiO_2.2H_2O$		Z=*c*	Orth. Fib. *c*.		do	H=2 to 2.5 G=2	β sepiolite. Does not gelat. with acid.
1.516	1.520	1.52	Carnegieite $Na_2O.Al_2O_3.2SiO_2$	36°	Rhomb. section. $Z\wedge$tw.=44°.	Tric.		Colorless	G=2.57	Feldspar group. Artificial. Tw. as microcline. Also at 60°.
1.513	1.525	1.524	Laumontite $CaO.Al_2O_3.4SiO_2.4H_2O$	25° $\rho<\upsilon$ strong.	Y=*b* $Z\wedge c=20°$ to 30°.	Mon. Elong. *c*.	{010}{110}very perf. {100} imperf.	White, etc	H=4 G=2.3	Zeolite. Gelat. F=2. Tw. pl. {100}.
1.518	1.526	1.524	Orthoclase $K_2O.Al_2O_3.6SiO_2$	0° to 70° Disp. weak.	Y or Z=*b* $X\wedge a=5°$.	Mon	{010}{001}perf.	White, colorless, pink, etc.	H=6 G=2.56	Feldspar group. Insol. in acids. F=5. Tw. ax. *c* and composition pl. {010}, others less common.
1.522	1.530	1.526	Microcline $K_2O.Al_2O_3.6SiO_2$	83° $\rho>\upsilon$ weak.	Ext. on{001}=15°. Ext. on{010}=5° to 6°.	Tric.	{010}{001}perf.	White, pink, etc.	H=6 G=2.56	Feldspar group. Insol. in acids. Infus. Tw. pl. {010}, also {100}, both poly., giving a very fine grating.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.523	1.531	1.529	Anorthoclase $(Na,K)_2O.Al_2O_3.6SiO_2$	32° to 54° $\rho>\upsilon$ weak.	Ext. on{001}= 1° to 6°. Ext. on{010}= 6° to 10°.	Tric.	{010}{001}perf.	White, etc.	H=6 G=2.58	Feldspar group. Insol. in acids. Infus. Tw. pl. {010}, also {100}, both poly., giving a very fine grating.
1.518	1.542	1.530	Minasragrite $V_2O_4.3SO_3.16H_2O$	Large.	X=*b*. Z∧fib. 12°.	Mon. or tric. Fib. Rhombs.	{010}perf.	Blue.		Very sol. in cold H_2O. F=easy. Pleoc. strong: X=deep blue, Y=pale blue, Z=nearly colorless.
B=0.003		1.532	Milarite $(H,K)_2O.2CaO.Al_2O_3.12SiO_2$	Small.	Z=*c*.	Ps. hex.		Pale green, etc.	H=6 G=2.57	Insol. in acid. F=3. Basal section shows six biax. segments. Uniax. at high temp.
1.515	1.536	1.532	Glauberite $Na_2O.CaO.2SO_3$	7° $\rho>\upsilon$ strong.	Z=*b*. Y∧*c*=14.2. Disp. strong.	Mon. Tab. {001}.	{001}perf.	Colorless, etc.	H=3 G=2.83	Slightly sol. in H_2O. Sol. in HCl. F=1.5 to 2.
1.513	1.535	1.533	Searlesite $Na_2O.B_2O_3.4SiO_2.2H_2O$	Large(?)	X∧*c*=30°	Mon.		White.	H=soft	Sol. in acid. Appreciably sol. in H_2O. F=easy.
1.489	1.557	1.534	Artinite $2MgO.CO_2.4H_2O$	Large.	Y usually // fibers.	Orth. Fib.		do.	H=2 G=2.03	
1.514	1.541	1.534	Zinc-copper chalcanthite. $ZnO.CuO.2SO_3.10H_2O$	Mod.		Tric.		Pale blue.	H=2 to 3 G=2.1	Sol. in H_2O. Nearly colorless in section. Near chalcanthite.
1.500	1.560	1.535	Meyerhofferite $2CaO.3B_2O_3.7H_2O$	79° $\rho>\upsilon$ perc.	Ext. on{100}. Z′∧*c*=25°. Ext. on{010}. X′∧*c*=33°.	Tric. Pris. *c*. Tab.{100}.	{010}perf.	Colorless.	H=2 G=2.12	Readily sol. in acid. F= easy with intumescence to an opaque enamel. Alteration of inyoite.
1.423	1.555	1.536	Teschemacherite $(NH_4)_2O.2CO_2.H_2O$	42° $\rho<\upsilon$ slight.	X=*a*. Y=*b*.	Orth.	{110} very perf. at 68°±.	Yellowish, white.	H=1.5 G=1.573 to 1.45	Sol. in H_2O. F=5.5.

1.517	1.543	1.536	Iron-copper chalcanthite. $FeO.CuO.2SO_3.10H_2O$	Mod.		Tric.		Pale blue	H=2 to 3 G=2.2	Sol. in H_2O. Near chalcanthite.
1.528	1.543	1.537	Siderotil $FeO.SO_3.5H_2O$	Mod. $\rho>v$ weak.		Tric.		Pale green, white.	H=2 to 3 G=2.2	Sol. in H_2O. F=3. Near chalcanthite.
1.534	1.540	1.538	Cordierite $4(Mg,Fe)O.4Al_2O_3.10SiO_2.H_2O$	78°± $\rho<v$ weak.	X=*c*. Z=*b*.	Orth. Elong. *c*.	{010}dist.	Blue, green-blue.	H=7 G=2.58±	Partly decpd. by acids. F=5.5. Pleoc. sometimes present: X=clear yellow, Y=dark violet, Z=clear.
B=0.008	....	1.539	Gismondite $CaO.Al_2O_3.4SiO_2.4H_2O$	83° $\rho<v$ small.	X=*b*. Y∧*c*=small.	Mon. Tetrag. bipyramids. Ps. tetrag. by tw.	None.	Colorless	H=4.5 to 5 G=2.27	Gelat. F=3. Section {001} shows four segments with opposite segments alike and ext. inclined at 5°.
1.516	1.546	1.539	Chalcanthite $CuO.SO_3.5H_2O$	56° $\rho<v$ perc.		Tricl. Flattened{111}.	{110}{1$\bar{1}$0}{111} imperf.	Berlin-blue to sky-blue.	H=2.5 G=2.2	Sol. in H_2O. F=3. Nearly colorless in section.
1.527	1.544	1.540	Sulphoborite $6MgO.2B_2O_3.2SO_3.9H_2O$	70°±	X=*c*. Z=*a*.	Orth. Pris.	{110}dist. {001}indist.	Colorless	H=4 G=2.4	Sol. in H_2O. Fus.
1.520	1.545	1.54	Lueneburgite $3MgO.B_2O_3.P_2O_5.8H_2O$	Medium	Y=*b*. X and Z to length nearly 45°.	Mon. Laths with *b* across.		do.	G=2.05	Sol. in acid. Fus.
1.500	1.543	1.541	Leverrierite $Al_2O_3.3\pm SiO_2.3\pm H_2O$	32°±	X=*c*.	Mon.(?) Plates{001}.	{001}mic.	Colorless, green, yellow, brown.	H=1.5 G=2.6	Infus. After standing in oils indices increase considerably.
1.466	1.596	1.542	Dawsonite $Na_2O.Al_2O_3.2CO_2.2H_2O$	77° $\rho<v$ weak.	Y=*c*. X=*a*.	Orth. Acic. *c*.	{110}perf.	White	H=3 G=2.40	Sol. in HCl. F=4.5 to 5.
1.539	1.547	1.543	Oligoclase Ab_4An	86° $\rho<v$ weak.	On {010} X′∧{001}=6°. On {001} X′∧{010}=1°.	Tric.	{001}perf. {010}less so.	Colorless, etc.	H=6 G=2.61	Feldspar group. $Ab_{80}An_{20}$. Insol. in acid. Infus. Tw. pl. {010} poly. almost universal, also other laws.
1.503	1.545	1.545	Pholidolite $K_2O.12(Fe,Mg)O.Al_2O_3.13SiO_2.5H_2O$	0 to 20°	X=*c*.	Mon. Hex. scales.	{001}mic.	Green	H=4 G=2.41	Nearly colorless in section.
1.542	1.547	1.545	Hyalophane $(K_2,Ba)O.Al_2O_3.4SiO_2(?)$	79°± $\rho>v$.	Z=*b*. Y∧*c*=5 to 24°.	Mon.	{010}{001}perf.	Colorless	H=6 G=2.80	Feldspar group. Ba orthoclase. Difficultly fus. Insol. in acids. Tw. axis *c* and composition pl. {010}; also other laws.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.539	1.551	1.546	Brushite $2CaO.P_2O_5.5H_2O$	Very large	Z=b. $Y \wedge a = 15\frac{1}{2}°$.	Mon. Flattened {010}.	{010}perf. {301}perf.	Colorless, pearly.	H=2 G=2.21	Sol. in dilute acid. F=3 with intumescence.
1.520	1.572	1.547	Copiapite $2Fe_2O_3.5SO_3$. $18 \pm H_2O$	90°± $\rho < \upsilon$ med.	X=c. Z bisects acute angle.	Orth. Tab. {001} Scales, crusts	{001}	Sulphur-yellow.	H=2.5 G=2.10	Janosite. Sol. in acid. F=4.5 to 5. Pleoc. in thick plates: Yellow to colorless.
1.439	1.595	1.547	Oxammite $(NH_4)_2O.C_2O_3.H_2O$	60° $\rho < \upsilon$.	X=c. Y=a.	Orth. Acic. c Tab. {100}.	{001}imperf.	White	H=soft G=1.46 to 1.50	Sol. in H_2O. F=easy.
1.531	1.552	1.549	Cobalt chalcanthite $CoO.SO_3.5H_2O$	Mod. Not strong.		Tric.		Rose-pink	H=2 to 3 G=2.2	Near chalcanthite. Sol. in H_2O. F=3.
1.538	1.554	1.549	Edingtonite $BaO.Al_2O_3.3SiO_2$. $3H_2O$	53° $\rho < \upsilon$ weak.	X=c. Z=a.	Orth. Ps. tetrag. Sphenoidal.	{110}perf.	White	H=4 G=2.7	Gelat. F=5.
1.53	1.55	1.55	Ascharite $2MgO.B_2O_3.2H_2O$	Small	Elong. —	Fib.		do	G=2.69	
1.552	1.559	1.555	Miloschite $(Al,Cr)_2O_3.2SiO_2$. $2H_2O$	90±	Inclined. Ext.	Mon. Clay-like. Tabular.	Traces	Pale greenish blue.	H=2½ G=2.1	A chromiferous kaolinite. Almost insol. in HCl. Infus. Color under microscope pale bluish green.
B=0.009		1.556	Okenite $CaO.2SiO_2.2H_2O$	Large	Z=c.	Orth. Elong. c.	Pris. poor	White	H=5 G=2.3	Zeolite group. Gelat. F=2.5.
1.552	1.561	1.558	Beryllonite $Na_2O.2GlO.P_2O_5$	68° $\rho < \upsilon$ small.	X=c. Z=b.	Orth. Short prisms b or tablets {001}.	{001} highly perf., {100} good, {110} poor.	Colorless to yellowish.	H=6 G=2.85	Sol. in acid. F=3. Luster on {001}pearly.
B=weak		1.56	Rivaite $(Ca,Na_2)O.2SiO_2$	Small	Y=elong. Z⊥ laths.	Mon. Fib. Laths c.		Pale lavender-blue to dark blue.	H=5 G=2.55	Not attacked by HCl. Easily fus. to a glass. Colorless in section.

1.54	1.560	1.560	Jefferisite $5(Mg,Fe)O.$ $2(Al,Fe)_2O_3.5SiO_2.$ $11H_2O$	0±	X ⊥ plates	Mic	{010} mic	White, green, brown, etc.	H=1.5 G=2.30	Vermiculite. Alteration of mica. Decpd. by HCl. Heated at 300° C., exfoliates very remarkably. On higher heating fuses.
B=mod.		1.56	Faratsihite $(Al,Fe)_2O_3.2SiO_2.$ $2H_2O$			Mon Hex. plates. Scales.		Pale yellow	Soft G=2.+	Between kaolinite and nontronite. Decpd. by HCl. F=dif.
1.552	1.563	1.562	Cordierite $4(Mg,Fe)O.4Al_2O_3.$ $10SiO_2.H_2O$	40°± $\rho<\upsilon$ weak.	X=*c* Z=*b*.	Orth Elong. *c*.	{010}dist	Blue, etc	H=7 G=2.66	Partly decpd. by acids. F=5.5. Pleoc. sometimes present: X=clear yellow, Y=dark violet, Z=clear.
1.548	1.567	1.562	Polyhalite $2CaO.MgO.K_2O.$ $4SO_3.2H_2O$	70°±		Tric Fib. *b*. Tab.{010}.	In two directions.	Flesh-red, yellow, etc.	H=3 G=2.78	Partly sol. in H_2O. F=1.5.
1.561	1.567	1.565	Kaolinite $Al_2O_3.2SiO_2.2H_2O$	68° $\rho>\upsilon$ weak.	Z=*b* $X\wedge c=4°$. $Y\wedge a=11°$.	Mon Minute hex. plates{001}.	{001}perf	White	H=2 G=2.6	Insol. in acids. Infus.
1.565	1.569	1.569	Epididymite $Na_2O.2GlO.6SiO_2$ H_2O	31° $\rho<\upsilon$.	X=*b* Y=*c*.	Orth Tab.{001} Elong. *a*.	{001}{010}perf.	Colorless	H=5.5 G=3.55	Partly sol. in acids. F=2.5 to 3. Tw.{001}at 60.
1.485	1.572	1.565	Griffithite $4(Mg,Fe,Ca)O.$ $(Al,Fe)_2O_3.5SiO_2.$ $7H_2O$	Small	X⊥cleav	Mon.? Plates{001}, shreds.	{001}mic	Dark green	Soft G=2.31	Chlorite group. Gelat. F=4. Pleoc.: X=pale yellowish, Y=olive green, Z=brownish green.
B= 0.025±		1.57±	Bowlingite Silicate of Fe,Mg,Al, H.	0 to 40°	X=*a* Z=c.	Orth.? Tab.{001}.	{100}perf		G=2.3	Serpentine. Easily sol. in HCl. F=dif. Pleoc.: X and Y=green or yellow, Z=green or dark red-yellow.
1.560	1.571	1.570	Antigorite $3MgO.2SiO_2.2H_2O$	20° to 90°	X=*b* Z=c.	Orth Fib. *c*.	{010}	Green	H=4 to 5 G=2.6±	Serpentine. Decpd. by HCl or H_2SO_4. Faintly pleoc.
1.524	1.583	1.571	Roemerite $FeO.Fe_2O_3.4SO_3.$ $14H_2O$	52° $\rho>\upsilon$ very strong.	On{101}ax. pl. bisects obtuse angle between {100} {010} X or $Z\wedge c=33°$. Disp. mkd.	Tric Tab.{001}.	{010}perf	Chestnut-brown.	H=3 to 3.5 G=2.15±	Sol. in H_2O. F=4.5 to 5. Very pronounced abnormal interference colors in some sections.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.555	1.575	1.572	Hannayite $3MgO.(NH_4)_2O.$ $2P_2O_5.10H_2O$	42° Disp. slight.	X = sensibly normal to perf. cleav. Y∧elong.=33°.	Tric. Slender prisms. Plates.	{001}{110} $\{1\bar{1}0\}$ {130}.	Yellowish.	H=soft G=1.89	
1.566	1.576	1.572	Bytownite $AbAn_4$	82°	On {010} X′∧{001}=33°. On {001} X′∧{010}=22°.	Tric.	{100} perf. {010} good.	Colorless, etc.	H=6 G=2.73	Feldspar group. $Ab_{20}An_{80}$. Gelat. F=5. Tw. {010}. poly., almost universal. Other tw. laws common.
1.56	1.580	1.574	Bassetite $CaO.2UO_3.P_2O_5.$ $8H_2O$	62°	X=*b*	Mon.	{010}{100}{001}	Yellow	G=3.10	Pleoc.: X=pale yellow, Y and Z=deep yellow.
...	...	...	Morinite $3Al_2O_3.2Na_2O.4P_2O_5.$ $6CaF_2.17H_2O$	...	...	...	...	Wine-red	H=4 G=2.9	Insol. in acid. F=easy.
1.541	1.574	1.574	Biotite $K_2O.4(Mg,Fe)O.$ $2(Al,Fe)_2O_3.6SiO_2.$ H_2O	0 to 50° $\rho<v$ perc.	X∧*c*=3°± Y=*b*.	Mon. Tab. {001}.	{001} very perf.	Black, etc.	H=3 G=3.	Mica group. Decpd. by H_2SO_4. F=dif. Strongly pleoc. in brown or green: X<Y and Z.
1.553	1.577	1.575	Autunite $CaO.2UO_3.P_2O_5.8H_2O$	30° $\rho>v$ perc.	X=*c*. Z=*a*.	Orth. Thin tablets {001}. Nearly tetrag.	{001} eminent.	Citron to sulphur yellow.	H=2 G=3.1	Sol. in acid. F=3. Luster on {001} pearly.
1.562	1.588	1.576	Sphaerite $5Al_2O_3.2P_2O_5.16H_2O$	Large	Z=*c*.	Orth. Concretions. Fib. *c*.	One dist.	Gray to blue.	H=4 G=2.54	
1.576	1.579	1.578	Penninite $5(Mg,Fe)O.Al_2O_3.$ $3SiO_2.4H_2O$	0± $\rho>v$ perc.	X∧*c*=0°±	Mon. Shreds.	{001} mic.	Green	H=2.5 G=2.7	Chlorite group. Decpd. by H_2SO_4. F=dif. Abnormal blue interference colors without ext. Pleoc.: X=nearly colorless, Y and Z=green.

1.544	1.601	1.578	Kroehnkite $CuO.Na_2O.2SO_3.$ $2H_2O$	79° $\rho<\upsilon$ weak.	$Y=b$ $X\wedge c=-18°$. Disp. red >blue.	Mon. Fib. *c*.	{010}perf. {011}dist.	Azure blue.	H=2.5 G=2.0	Sol. in H_2O. F=1. Tw. pl. {001}.
B=0.03		1.58	Cryophyllite $3(Li,K)_2O.2FeO.$ $4Al_2O_3.20SiO_2.$ $3H_2O.8(Li,K)F$			Mon	{001}perf.	Dark green.		Mica group. Variety zinnwaldite. Dif. sol. in acid. Fus. Pleoc.: X=emerald-green, Z and Y=brownish red.
1.55	1.59	1.58(?)	Ježekite $2Na_2O.CaO.$ $Al_2O(F,OH)_4.$ P_2O_5	Medium.	$Y=b$ $X\wedge c=29°$.	Mon. Pris. *c*.	{100}perf {001}imperf.	Colorless.	H=4.5 G=2.94	
1.554	1.582	1.582	Leverrierite $Al_2O_3.3\pm SiO_2.$ $2\pm H_2O$	0 to 50°.	$Y=b$ X nearly ⊥ {001}.	Mon. Plates. Vermicular.	{001}mic.	Colorless to brown from organic pigment.	H=1.5 G=2.6	Pleoc. variable: X=colorless, Y=dark brown, Z=clear brown. In water becomes plastic. Loses its water below 200° C.
1.560	1.587	1.582	Uranospinite $CaO.2UO_3.As_2O_5.$ $8H_2O$	46° $\rho>\upsilon$ rather strong.	$X=c$ Z=long dir.	Orth. Rect. plates{001}.	{001}perf.	Pale yellow, etc.	H=2 to 3 G=3.45	Sol. in acid. Fus. Pleoc.: X=colorless, Y and Z=pale canary yellow.
1.574	1.582	1.582	β hopeite $3ZnO.P_2O_5.4H_2O$	0± Disp. weak.	$X=b$ $Y=a$ or c.	Orth. Elong. *c*	{100}perf. {010}dist.	Grayish.	H=3 G=3.03	Sol. in acids. F=5.
1.562	1.587	1.583	Peganite $2Al_2O_3.P_2O_5.6H_2O$	53°.	X ⊥ cleav.	Orth. Pris.	{010}{001}{110} good.	Siskin-green.	H=3 to 3.5 G=2.50	Sol. in acids. Infus.
1.576	1.588	1.584	Anorthite $CaO.Al_2O_3.2SiO_2$	77° $\rho<\upsilon$.	On{010}X′∧{001}=−37°. On{001}X′∧{010}=−40°.	Tric.	{010}{001}perf.	White.	H=6 G=2.765	Feldspar group. Ab_0An_{100}. Gelat. F=5. Poly. tw. {010}. Almost universal. Other laws common.
1.563	1.592	1.585	Lucinite $Al_2O_3.P_2O_5.4H_2O$	57° $\rho>\upsilon$ mod.		Orth. Oct.	None.	Green.	H=5 G=2.52	Compare with Peganite (above). In section pale green and nonpleoc.
B=mod.		1.585	Volchonskoite $(Cr,Fe,Al)_2O_3.2SiO_2.$ $2H_2O$			Mon.(?)		Green.	H=2.5 G=2.2 to 2.3	A chrome kaolinite. Gelat. with HCl. Infus.
1.56	1.585	1.585	Nontronite $(Ca,Mg)O.2Fe_2O_3.$ $8SiO_2.7\pm H_2O$	Small $\rho<\upsilon$ perc.	X ⊥ cleav. Z // elong.	Orth.(?) Plates and fib.	One mic.	Dark olive-green to yellow or orange.	Soft. G=2.50	Gelat. Pleoc.: X=pale yellow, Y=olive-green, Z=yellowish to bright green. When wet it is claylike. Alters to a yellow or orange type with higher index of refraction.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.52	1.613	1.587	Lanthanite $La_2O_3.3CO_2.9H_2O$	62° $\rho<v$ weak.	$X=c$ $Z=b$.	Orth. Thin plates{001}.	{001}mic	White	H=3 G=2.60 to 2.74	Sol. in acid. Infus.
1.552	1.600	1.588	Pyrophyllite $Al_2O_3.4SiO_2.H_2O$	57° $\rho>v$ weak.	$X=c$ Z // length.	Orth. Tab. {001}. Blades and fib.	{001}eminent	White, gray, apple-green, etc. Pearly.	H=1 to 2 G=2.8 to 2.9	Difficultly sol. in H_2SO_4. F=difficult.
1.539	1.589	1.589	Talc $3MgO.4SiO_2.H_2O$	6 to 30° $\rho>v$ perc.	$X=c$	Mon.(?) Orth.(?)	{001}mic	**Green**	H=1 G=2.7	Insol. in acid. F=6. Pearly luster.
1.583	1.594	1.589	Pharmacolite $2CaO.As_2O_5.5H_2O$	77° $\rho>v$.	$Z=b$ $X\wedge c=70°$.	Mon. Pris. *a*.	{010}perf	**White**	H=2 G=2.7	Sol. in acids. F=2.5. Luster on {010} pearly.
1.572	1.59	1.591	α hopeite $3ZnO.P_2O_5.4H_2O$	36°± $\rho<v$ weak.	$X=b$ $Y=c$.	Orth. Elon. *c*.	{100}perf {010}dist.	**Grayish**	H=3 G=3.03	Sol. in acids. F=5.
1.561	1.594	1.590	Muscovite $K_2O.3Al_2O_3.6SiO_2.2H_2O$	40°± $\rho>v$ perc.	$Z=b$ $X\wedge c=0\pm$.	Mon. Hex. tablets{001}.	{001}mic	Colorless	H=2 G=2.9±	Mica group. Insol. in acid. F=5.7. Tw. pl. {001}.
1.58	1.600	1.590	Nontronite $(Ca,Mg)O.2Fe_2O_3.8SiO_2.7\pm H_2O$	Large	$X\perp$ cleav. Z // elong.	Orth.? Plates and fibers.	One mic.	Dark olive-green to yellow or orange.	Soft G=2.50	Gelat. Pleoc.: X=orange to yellow orange, Y=orange-yellow, Z=yellowish green to bright green. Data from partly altered mineral.
1.54	1.605	1.59	Diabantite $12(Mg,Fe)O.2Al_2O_3.9SiO_2.9H_2O$	Med.	$X=c$ Z // fibers.	Mon. Plates {001}. Fib.	{001}mic	Green to black.	H=2 G=2.8±	Chlorite group. Pleoc.
1.572	1.594	1.591	Priceite $5CaO.6B_2O_3.9H_2O$	32° $\rho<v$ rather strong.	X to normal to plates 25°±. Ext. on plates Y' to bisectrix of acute angle of rhombs =14°±.	Tric. Minute rhombic plates, angle 58°.		Snow-white chalky.	H=3 G=2.4	Sol. in acid.

1.582	1.592	1.592	Torbernite $CuO.2UO_3.P_2O_5.8H_2O$	Very small $\rho>v$.	X=c	Orth. Ps. tetrah.	{001}perf.	Green, yellow, red.	H=2 G=3.4 to 3.6	Sol. in H_2SO_4 or HNO. F=2.5.
1.579	1.597	1.593	Amblygonite $Al_2O_3.P_2O_5.2LiF$	52°± $\rho>v$ small.	Ax. pl. 12½° to {100}, 67° to {001}. X to edge {100} {001} is 11.8°. Disp. strong.	Tric.	{001}perf. {100}less so. {0$\bar{2}$1}rare.	White.	H=6 G=3.05	Sol. in H_2SO_4. F=2. Poly. tw. in two directions at 90°.
1.55	1.594	1.594	Alurgite $6(H,K)_2O.2MgO.3Al_2O_3.12SiO_2$	0 to 57° $\rho>v$ weak.	X=c	Plates and scales.	{001}mic.	Copper-red, purple, etc.	H=3 G=2.84	Mica group. Insol. in acid. F=3. Pleoc. slight.
1.570	1.597	1.594	Astrolite $(Na,K)_2O.FeO.(Al,Fe)_2O_3.5SiO_2.H_2O$	30° $\rho>v$ perc.	X ⊥ plates	Orth. Radiating globules, plates, and fibers.	Lamellar	Greenish yellow.	H=3.5 G=2.78	Insol. in acid. F=3.5. Pleoc.: X=nearly colorless, Y and Z=siskin-green.
B=0.04		1.594	Fuchsite Chromium mica.	40° $\rho>v$ strong.	X=c	Mon. Plates.	{001}mic.	Green.	H=2.5 G=2.86	Mica group. Near muscovite. Insol. in acid. F=5. Pleoc.: X = robin's-egg blue, Y=yellowish green, Z=bluish chrome-green.
1.575	1.611	1.594	Gilpinite $RO.UO_3.SO_3.4H_2O$ R=Cu,Fe,Na_2	87° $\rho>v$ strong.	X=b $Y\wedge c=7°$. Disp. strong.	Mon. Laths{010}. Elong. c.		Yellow.	H=2 to 2.5 G=3.9±	Sol. in HCl. Infus. Pleoc.: X=colorless, Y=pale yellow, Z=canary - yellow. Poly. tw. {100}.
1.571	1.598	1.595	Leucophanite $GlO.CaO.2SiO_2.NaF$	39° $\rho>v$ weak.	X=c Z=b.	Orth. Tab.{001}.	{001}perf. {021} {201} {100} {010} dist.	Green to pale yellow.	H=4 G=2.96	Insol. in acids. F=3. Tw. pl. {110} or {001}frequent.
1.592	1.599	1.597	Cordierite $4(Mg,Fe)O.4Al_2O_3.10SiO_2.H_2O$	70°± $\rho<v$ weak.	X=c Z=b.	Orth.	{010}dist.	Blue, etc.	H=7 G=2.66±	Partly decpd. by HCl. F=5.5. Pleoc. at times: X=clear yellow, Y=dark violet, Z=clear.
1.575	1.598	1.597	Chrysocolla $CuO.SiO_2.nH_2O$(?)	Small		Fib.		Green.	H=2± G=2.4±	Decpd. by acid. Infus. Faintly pleoc.
1.560	1.605	1.598	Lepidolite $Al_2O_3.3SiO_2.2(K,Li)F$	40°± $\rho>v$.	X∧⊥{001}=1°.	Mon. Hex. plates {001}.	{001}mic.	Pink, red, violet.	H=3 G=2.9	Mica group. Nearly insol. in HCl. F=2.5. Pleoc.: X=colorless, Y and Z=pink.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.586	1.605	1.598	Howlite $4CaO.5B_2O_3.2SiO_2.5H_2O$	Large	$X=b$ $Z\wedge c=44°\pm$.	Mon. Tab.{100}. Elong. *c*.		White	H=3.5 G=2.58	Insol. in HCl. F=2.
B=0.053		1.60	Chloraluminite $AlCl_3.nH_2O$							
B=0.03		1.60	Zinnwaldite $Al_2O_3.3SiO_2.2(K,Li)F$ with $2FeO.SiO_2$	0 to 68° $\rho<v$ weak.	$X\wedge c=0°$ to 4°.	Mon. Hex. plates {001}.	{001}mica	Green, violet.	H=3 G=3±	Mica group. Dif. sol. in HCl. F=1.5 to 2. Pleoc.: X=nearly colorless, Y and Z=dark brown.
1.586	1.602	1.600	Spencerite $4ZnO.P_2O_5.4H_2O$	49° $\rho>v$ mod.	$Z=b$ X near *a*.	Mon. Tab.{100}.	{100}very perf. {010} perf. {111}less so. The three are nearly at 90°.	White	H=3 G=3.14	Sol. in acid. F=readily. Tw. and composition face {100}, lamellar. Ext. against lamellae 6°.
1.555	1.600	1.600	Leverrierite $Al_2O_3.3\pm SiO_2.3\pm H_2O$	0±	$X=c$	Mon.(?) Plates{001}.	{001}mic.	Colorless, green, yellow, brown.	H=1.5 G=2	Infus. Indices measured after standing in oil for some time. Plastic when wet.
B=0.03		1.60	Paragonite $Na_2O.3Al_2O_3.6SiO_2.2H_2O$	40°±	$X\wedge\perp\{001\}=0$ to 2°.	Mon. Hex. plates {001}.	{001}mic.	Colorless	H=3 G=2.8	Mica group. Insol. in HCl. F=dif.
1.591	1.614	1.605	Bertrandite $4GlO.2SiO_2.H_2O$	75° $\rho<v$ weak.	$X=a$. $Z=c$.	Orth. Tab. {001}. Rhombic in outline.	{110}perf. {100} {001} {010}.	Pale yellow to colorless.	H=6.5 G=2.6	Insol. in acids. Infus. Heart-shaped tw.
1.51	1.611	1.605	Amarantite $Fe_2O_3.2SO_3.7H_2O$	28° $\rho<v$ strong.	Ext. on {100}. Ax. pl. is 38° to *c*. X nearly ⊥ {100}.	Tric. Blades, fib.	{100}{010}perf.	Amaranth-red.	H=2.5 G=2.11	Sol. in HCl. F=4.5 to 5. Pleoc.: X=nearly colorless, Y=pale orange-yellow, Z=orange-yellow.

1.562	1.606	1.606	Phlogopite $K_2O.6MgO.Al_2O_3.6SiO_2.2H_2O$	0° to 35° $\rho<v$ weak.	$X\wedge c=0\pm$ $Y=b$.	Mon.	{001}mic.	Brown, green, pale.	H=3 G=2.8	Mica group. Decpd. by H_2SO_4. F=dif. Pleoc. faint: X=yellow, Y=brownish green, Z=brownish red. Abs.: X<Y<Z.
1.595	1.620	1.61	Nontronite $Fe_2O_3.2SiO_2.2H_2O$		$Z\wedge$elong.small	Mon. Fib.	{001}perf.	Yellow, white, yellow-green.	H=3 G=2.08 to 2.29.	Decpd. by HCl. Infus. Pleoc.: X and Y=yellow-green, Z=brown-green to olive-green.
1.605	1.612	1.61	Hillebrandite $2CaO.SiO_2.H_2O$	70°(?)	$Z=c$. $Y=b$(?).	Orth.(?) Fib.	Pris.	White.	H=5.5 G=2.69	Sol. in HCl. F=dif.
1.600	1.620	1.611	Montebrasite $Al_2O_3.P_2O_5.2Li(OH,F)$	Large.	Axial pl. to {001} is 23°; to{100}is 82°. X nearly // {100}{001}.	Tric.	{001}perf. {100}less so.	do.	H=6 G=3	Variety of amblygonite. Sol. in H_2SO_4. F=2.
1.592	1.621	1.612	Herderite $CaO.2GlO.P_2O_5.Ca(F,OH)_2$	74° $\rho>v$.	$Y=b$ $Z\wedge c=2.5°$. Disp. dist.	Mon. Short prisms *a*.	{110}poor.	Yellowish to greenish.	H=5 G=3.01	Sol. in HCl. F=dif. Tw. pl. {001}penet.
1.593	1.613	1.613	Meliphanite $2CaO.2GlO.3SiO_2.NaF$	Small.	$X=c$.	Ps. tetrag.	{001}dist.	Yellow, red, black.	H=5 G=3.0	Insol. in HCl. Fus. Pleoc. in thick plates: X=green-yellow, Z=honey-yellow to brownish yellow.
B=0.014		1.619	Delessite $4(Mg,Fe)O.2Al_2O_3.4SiO_2.5H_2O$	0±	X=⊥{001}.	Mon. Spherulites.	{001}mic.	Olive-green, etc.	H=2 G=2.8±	Easily sol. in acids. F=dif. Pleoc.: X=pale green to colorless or pale yellow to colorless, Y and Z=green or pink.
B = very weak.		1.62	Torbernite $CuO.2UO_3.P_2O_5.8H_2O$.	Near 0 Disp. very strong.	$X=c$.	Ps. tetrag. Sq. tablets {001}.	{001}perf.	Emerald-green to grass-green.	H=2 to 2.5 G=3.5	Sol. in HNO_3. Abnormal blue and red interference colors.
1.609	1.635	1.623	Tremolite $CaO.3MgO.4SiO_2$	85°± $\rho<v$.	$Y=b$. $Z\wedge c=17°\pm$.	Mon. Pris. *c*.	{110} perf. at 121°.	Colorless, etc.	H=6 G=3.0	Amphibole group. Insol. in acid. F=4.
1.610	1.623	1.623	Uranocircite $BaO.2UO_3.P_2O_5.8H_2O$	10°	$X=c$. $Z=a$.	Orth. Thin tablets{001}.	{001}perf. {100} {010} dist.	Yellow-green.	H=2 G=3.5	Luster on {001} pearly. Sol. in HCl. F=3(?). Pleoc.: X=colorless, Y and Z=pale canary-yellow. Poly. tw.
B=small	1.625		Francolite $10CaO.3P_2O_5.CO_2.CaF_2.H_2O$	Small.	$X=c$.	Ps. hex.		Colorless.	H=4 G=3.1	Basal section shows six segments, with opt. pl. // hex. sides.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=0.037±	1.625		Nepouite. 3(Ni, Mg)O.$2SiO_2$. $2H_2O$	Small.	X=*c*.	Ps. hex. Plates {001}.	{001} perf. Also one // opt. pl.	Pale to deep brown.	H=2 to 2.5 G=2.47 to 3.24	Pleoc.: X=green, Y and Z=yellow green.
B=rather strong.		1.625	Roscherite. 2FeO.3MnO.3CaO. $2Al_2O_3.4P_2O_5$. $10H_2O$	Large. ρ>υ very strong.	X=*b*. Y∧*c*=−15°. Crossed disp.	Mon. Tab. {010}.	{001} perf. {010} fair.	Brown.	H=4.5 G=2.92	Pleoc.: X=yellow to olive-green, Y=yellow-brown, slightly greenish, Z=chestnut-brown.
1.611	1.636	1.627	Actinolite. CaO.3(Mg,Fe)O. $4SiO_2$	78°. ρ<υ.	Y=*b*. Z∧*c*=15°.	Mon. Pris. *c*.	{110} at 124° perf.	Green.	H=6 G=3.15	Amphibole group. Insol. in HCl. F=4. Pleoc.: X=yellow, Y=green, Z=green.
1.610	1.628	1.628	Glauconite. $K_2O.Fe_2O_3.4SiO_2$. nH_2O	20°.	X near *c*.	Mon. Fib. grains.	{001} very perf.		H=2 G=2.2 to 2.8.	F=easy. Pleoc.: X=straw yellow, Y and Z=clear green with a bluish tint.
1.616	1.631	1.629	Wollastonite. $CaO.SiO_2$	39°. ρ>υ perc.	Y=*b*. X∧*c*=32°.	Mon. Tab. {100} or {001}. Elong. *b*.	{100} perf. {001} less so.	Colorless.	H=5 G=2.9	Pyroxene group. Data for pure artificial mineral. Decpd. by HCl. F=4. Tw. pl. {100}.
1.60	1.63	1.63±	Mariposite. Chromiferous mica.	0±.	X=*c*.	Mon. Hex. plates {001}.	{001} mic.	Light apple-green.	H=5 G=2.79	Mica group. Near alurgite. Insol. in acid. F=3. Pleoc.: Z>Y and X.
1.585	1.630	1.630	Troegerite. $3UO_3.As_2O_5.12H_2O$	0±.	X=*c*.	Mon.? Ps. tetrag. Tab. {001}.	{001} perf. {100} good.	Lemon-yellow.	Soft. G=3.23	Sol. in HCl. F=2.5.
1.602	1.632	1.632	Bementite. $8MnO.7SiO_2.5H_2O$	0±.	X⊥flat face of fib. Z or Y=elong.	Orth. Fib., plates.		Brown.	H=6 G=2.83 to 3.11.	Decpd. by acid. F=easy to a black glass. Faintly pleoc. Abs.: X and Y<Z.
<1.62	>1.64	1.63	Bityite. $7(H_2,Li_2,Ca,Gl)O$. $4Al_2O_3.5SiO_2$		X=*c*. Z∧{10$\bar{1}$0}=30°.	Ps. hex.	{0001} easy.	Yellowish.	H=5.5 G=3.05	Insol. in HCl. Fus. Basal section divided into six sectors, and these show poly. tw. with tw. pl. {10$\bar{1}$0}.

B=0.022	....	1.63	Carpholite.......... $MnO.Al_2O_3.2SiO_2.$ $2H_2O$	60°±..........	X=*b*.......... Z=*c*.	Orth..........	Pris. at 68.5°..	Straw-yellow..	H=5.5 G=2.94	Nearly insol. in HCl. F=3.5. Silky. Pleoc.: X and Y=pale yellow, Z=colorless.
1.62	1.64	1.63	Richterite.......... $(K_2,Na_2,Mg,Ca,$ $Mn)O.SiO_2$	80°±.......... $\rho<v$.	Y=*b*.......... Z∧*c*=15°±.	Mon.......... Pris. *c*.	{110} perf. at 124°.	Brown, yellow, rose-red.	H=6 G=3	Amphibole group. Insol. in HCl. F=4. Pleoc.: X=brown, Y=colorless, Z=yellow.
1.625	1.638	1.63	Celadonite.......... Fe,Mg,K,Si,O Near glauconite.	....	Elong.+	Earthy....... Fib.	Mic..........	Green..........	H=1± G=2.7±	Sol. in HCl. F=3. Alteration product in igneous rocks. Pleoc.: X=light yellow-green, Y and Z=dark green.
1.603	1.639	1.632	Lazulite.......... $(Fe,Mg)O.Al_2O_3.$ $P_2O_5.H_2O$	69°±.......... $\rho<v$.	Y=*b*.......... X∧*c*=−9° to 10°.	Mon.......... Pyramids c.	{110} indist....	Azure blue....	H=5 to 6 G=3.1	Insol. in HCl. Infus. Pleoc.: X=colorless, Y and Z=azure blue. Tw. axis *c*.
1.621	1.635	1.633	Wollastonite.......... $CaO.SiO_2$	40°.......... $\rho>v$ perc.	Y=*b*.......... X∧*c*=32°.	Mon.......... Tab. {100} or {001}. Elong. *b*.	{100} perf..... {001} less so; {101}{102} rare.	Colorless......	H=5 G=2.9	Pyroxene group. Decpd. by HCl. F=4. Tw. pl. {100}.
1.632	1.636	1.634	Danburite.......... $CaO.2SiO_2.B_2O_3$	88°.......... $\rho<v$ strong.	X=*b*.......... Z=*a*.	Orth.......... Elong. *c*.	{001} poor.....	Colorless, wine-yellow.	H=7 G=3.0	Insol. in HCl. F=dif.
1.602	1.639	1.636	Grandidierite.......... $2(Na,H)_2O.$ $7(Mg,Fe,Ca)O.$ $11(Al,Fe)_2O_3.7SiO_2.$	30°.......... $\rho<v$ strong.	X=*a*.......... Z=*b*.	Orth..........	{100}{010} unequal.	Blue-green....	G=2.99	Insol. in HCl. Infus. Pleoc.: X=greenish blue, Y=colorless, Z=pale bluish green.
1.609	1.644	1.636	Inesite.......... $2(Mn,Ca)O.2SiO_2.$ H_2O	60°.......... $\rho>v$ perc.	X nearly ⊥ {010}. Ext. on {010}. Z∧cleav.=50°.	Tric.......... Pris.	{010} perf..... {100} less so.	Rose-red to flesh-red.	H=6 G=3.03	Decpd. by HCl. F=3.
1.623	1.644	1.636	Gedrite.......... $(Mg,Fe)O.SiO_2$	78°±.......... $\rho>v$.	X=*a*.......... Z=*c*.	Orth.......... Pris. *c*.	{110} perf. at 124°.	Grayish yellow, pinkish brown.	H=6 G=3.1	Amphibole group. Insol. in acid. F=3 to 4.
B=0.022±	....	1.638	Cumingtonite.......... $(Fe,Mg)O.SiO_2$	78°±.......... $\rho<v$.	Y=*b*.......... Z∧*c*=15°.	Mon.......... Pris. *c*.	.....do........	Gray, brown..	H=6 G=3.2	Amphibole group. Insol. in HCl. Fus. Pleoc.: X and Y=pale yellow, Z=brown-yellow.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.586	1.638	1.638	Lepidomelane $K_2O.4(Fe,Mg)O.2(Al,Fe)_2O_3.6SiO_2.H_2O$	0 to 40° $\rho<v$.	$Y=b$ $X\wedge c=0\pm$.	Mon. Hex. tablets.	{001} mic.	Black, brown.	H=3 G=3.1±	Mica group near biotite. Gelat. F=4.5 to 5. Pleoc.: Marked in browns or greens. Abs.: Y and Z >X.
1.621	1.638	1.638	Glaucophane $Na_2O.2(Fe,Ca,Mg)O.Al_2O_3.6SiO_2$	45°± $\rho<v$ strong.	$Y=b$ $Z\wedge c=5°\pm$.	Mon. Pris. *c*.	{110} perf. at 124°.	Blue to bluish black.	H=6 G=3.1	Amphibole group. Insol. in acid. F=3 to 3.5. Pleoc.: X=yellowish, Y=violet-blue, Z=dark blue.
1.632	1.643	1.638	Andalusite $Al_2O_3.SiO_2$	85°	$X=c$ $Z=a$.	Orth. Needles. Fib. *c*.	{110} perf.	Colorless, red, etc.	H=7.5 G=3.2	Insol. in acid. Infus. Pleoc. common: X=rose-red, Y and Z=nearly colorless.
B=mod.?		1.64	Jeremejevite $Al_2O_3.B_2O_3$	Small, variable	$X=c$	Ps. hex. Pris.	None	Colorless	H=6.5 G=3.28	Insol. in acid. Infus. Basal section divided into six segments.
1.632	1.645	1.643	Margarite $CaO.2Al_2O_3.2SiO_2.H_2O$	0 to 67° $\rho<v$.	$Y=b$ $X\wedge c=6°\pm$.	Mon. Hex. tablets {001}.	{001} highly perf.	Gray, etc.	H=4 G=3.0	Brittle mica. Partly decpd. by H_2SO_4. F=dif. Luster on base pearly.
B=0.01		1.64±	Thuringite $8FeO.4(Al,Fe)_2O_3.6SiO_2.9H_2O$	Small	$X=c$	Mon. Hex. plates {001}.	{001} mic.	Olive to pistachio green.	H=2.5 G=3.13 to 3.19.	Chlorite group. Gelat. F=4.
1.584	1.647	1.642	Serpierite $(Cu,Zn,Ca)O.SO_3.H_2O$	34° $\rho>v$ strong.	$X=c$ $Z=b$.	Orth. Tab.	{001} very perf	Bluish		Pleoc.: X=pale greenish, Y and Z=deep greenish-blue.
1.629	1.653	1.642	Hornblende Silicate of Al, Fe, Mg, Ca, Na.	84°± $\rho<v$.	$Y=b$ $Z\wedge c=15°$ to 25°.	Mon. Pris. *c*.	{110} perf. at 124°.	Green to black, brown.	H=6 G=3	Amphibole group. Insol. in acid. F=3 to 4. Pleoc. in green and brown. Abs.: Z>Y>X.
B=0.03		1.645	Nontronite $(Ca,Mg)O.2Fe_2O_3.8SiO_2.7\pm H_2O$	Small	$X\perp$ cleav. $Z\,//$ elong.	Interwoven fib.	One mic.	Yellowish green.	Soft G=2.50	Gelat. Pleoc. in yellow-brown. Abs.: X>Z.

1.624	1.647	1.647	Bementite $8MnO.7SiO_2.5H_2O$	Near 0	X=c	Orth Plates{001}, fib.	{001} mic {010} {100} perf.	Gray to brown Weathers darker.	H=6 G=3.11	Decpd. by acid. F=easy.
1.643	1.649	1.649	Daphnite $3FeO.Al_2O_3.2SiO_2.3H_2O$	Small	X=c	Mon Fib. and plates.	{001} mic	Dark green	H=3	Chlorite group. Decpd. by hot HCl. Pleoc.: X=pale yellowish, Y and Z=olive-green.
1.585	1.660	1.649	Herrengrundite $3CuO.2SO_3.6H_2O$	38° $\rho<v$ marked	X near c. Z=b.	Mon Thin tablets.	{001} perf. {110} dist.	Emerald-green to bluish green.	H=2.5 G=3.13	Sol. in HCl. F=3.5 Pleoc.: X=very pale green, Y=Venice-green, Z=turquoise-green. Abs.: X>Y>Z. Tw. pl. {001}.
B=0.03		1.65	Friedelite $9MnO.8SiO_2.MnCl_2.7H_2O$	Small		Trig	{0001} perf.	Rose-red	H=4 to 5 G=3.07	Decpd. by HCl. F=4 (to a black glass). Anom. biax. Pleoc.: X=colorless, Y and Z=greenish yellow.
1.625	1.655	1.65	Nontronite $Fe_2O_3.3SiO_2.5\pm H_2O$	33°	X nearly ⊥ {001}.	Mon Fib., etc.	{001} dist.	Greenish yellow, earthy.	H=2.5 to 4.5 G=1.7 to 2.4	Decpd. by HCl. Infus. Pleoc.: X=nearly colorless, Y and Z=yellow to greenish yellow.
1.610	1.682	1.650	Epistolite $5Na_2O.2Cb_2O_5.9(Si, Ti)O_2.10H_2O$	80°± $\rho<v$.	Y=b Z∧c=7°±. Disp. perc.	Mon Rect. plates {001}.	{001} very perf. {110} dist. Very brittle.	White, yellow, gray.	H=1 to 1.5 G=2.89	
B=0.025		1.65	Phosphophyllite $K_2O.8(Mg, Fe)O.3(Al, Fe)_2O_3.3P_2O_5.2SO_3.12H_2O$.	43°	Y=b	Mon Plates{100}, Pris.	{001} perf {100}{010} good.	Colorless to pale greenish blue.	H=3 to 4 G=3.08	Tw. on c.
1.612	1.675	1.652	Liroconite $18CuO.4Al_2O_3.5As_2O_5.55H_2O$	67° $\rho<v$ mod.	X=b. Z∧c=−25°.	Mon Oct.	{110} {011} indist.	Sky-blue to verdigris-green.	H=2 to 2.5 G=2.88 to 2.98	F=3 to 3.5. In section turquoise-green and nonpleoc.
1.625	1.669	1.653	Datolite $2CaO.2SiO_2.B_2O_3.H_2O$	74° $\rho>v$ weak.	Y=b Z∧c=−1° to 4°. Disp. perc.	Mon Elong. c.	None	Colorless	H=5 G=3.0	Gelat. F=2 to 2.5.
1.62	1.689	1.654	Cabrerite $3(Ni,Mg)O.As_2O_5.8H_2O$	90°± $\rho>v$ strong.	X=b. Z∧c=33°±. Disp. marked.	Mon Fib. c.	{010} perf.	Apple-green	H=2 G=2.96 to 3.11	Near annabergite. Sol. in HCl. F=4 to 5.
1.647	1.660	1.654	Hureaulite $5MnO.2P_2O_5.5H_2O$	74° $\rho<v$ very strong.	X=b. Z ∧ c = 75°. Disp. strong.	Mon Tab. {100}.	{100} rather perf	Orange, red, violet, etc.	H=5 G=3.18	Sol. in acid. F=3. Pleoc. faint: X=colorless, Y=clear yellow to pale rose, Z=reddish yellow to reddish brown.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.633	1.662	1.655	Eosphorite. $2MnO.Al_2O_3.P_2O_5.4H_2O$	51°± $\rho<\upsilon$ strong.	X=*b*. Z=*c*.	Orth.	{100}nearly perf	Rose, pink, yellow, etc.	H=5 G=3.11 to 3.14	Sol. in HCl. F=4. Pleoc. feeble: X=yellowish, Y=deep pink, Z=nearly colorless.
1.652	1.660	1.656	Palaite. $5MnO.2P_2O_5.4H_2O$	Large. Disp. weak.		Mon.	None(?).	Flesh-colored.	G=3.2	Readily sol. in acid. F=easy. Alteration of lithiophilite.
1.646	1.658	1.657	Seybertite. $10(Mg,Ca)O.5Al_2O_3.4SiO_2.3H_2O$	5° $\rho<\upsilon$ weak.	Z=*b*. X ∧ ⊥{001} small.	Mon. Hex.tablets {001}.	{001}perf.	Reddish brown, copper-red.	H=5 G=3.0	Brittle mica. Insol. in acid. Infus. Pleoc. feeble: X=colorless, Y and Z=pale brownish-yellow.
1.622	1.687	1.658	Annabergite. $3NiO.As_2O_5.8H_2O$	84° $\rho>\upsilon$ rather strong.	X=*b*. Z∧edge 36°± Disp. marked.	Mon. Plates{010}, elong. *c*.	{010}perf.	Apple-green.	H=2.5 to 3 G=3.0 to 3.1.	Sol. in HCl. F=4.
1.648	1.660	1.660	Brandisite. $12(Mg,Ca)O.6(Al,Fe)_2O_3.5SiO_2.4H_2O$	18° to 35°. $\rho<\upsilon$.	Y=*b*. X∧⊥{001}. small.	Mon. Hex.tablets.	{001}perf.	Leek-green, dark green.	H=5 G=3.0	A brittle mica. Near seybertite. Insol. in acid. Infus. Pleoc.: X=pale orange-yellow, Y and Z=pale green.
1.640	1.675	1.660	Tilasite. $2CaO.MgO.As_2O_5.MgF_2$	83°	X ⊥ cleav.	Mon.	One perf.	Pale green.	H=5 G=3.77	Sol. in acids. F=4 to 5(?).
1.649	1.661	1.660	Xanthophyllite. $14(Mg,Ca)O.8Al_2O_2.5SiO_2.4H_2O$	20° to 40° $\rho<\upsilon$ weak.	Y=*b*. Z∧*a*=0.5°.	Mon. Tab. {001}.	{001}perf.	Leek-green	H=4.5 to 6 G=3.09	A brittle mica. Insol. in acid. Infus. Pleoc.: X=reddish-brown, Y and Z=green. Tw after mica law, polysynthetic.
1.63	1.69	1.66	Stewartite $3MnO.P_2O_5.4H_2O$(?)	Very large Disp. strong.	X nearly ⊥ {100}. On cleav. X∧*c*=56°. Cleav. shows an opt. axis in field.	Tric. Tab. {100}. Fib.	{010}good	Yellow	G=2.94	Pleoc.: X=colorless, Y=very pale yellow, Z=yellow.

1.626	1.699	1.661	Erythrite $3CoO.As_2O_5.8H_2O$	90°± $\rho>v$ weak.	X=*b*. $Z\wedge c=-31°$.	Mon. Pris. *c*. Vertically striated.	{010} highly perf.	Crimson to gray.	H=2 G=2.95	Sol. in HCl. F=2. Pleoc. strong: X=pale pink, Y=very pale violet, Z=red. Abs.: X and Y<Z.
1.651	1.668	1.662	Monticellite $CaO.MgO.SiO_2$	38° $\rho>v$.	X=*b*. Z=*a*.	Orth. Equant	{010}poor	Colorless, etc.	H=5 to 5.5 G=3.2	Olivine group. Gelat. F=6.
1.520	1.667	1.667	Strontianite $SrO.CO_2$	7° $\rho<v$ weak.	X=*c*. Z=*a*.	Orth. Elong.*c*.	{110}nearly perf {010}tr.	do	H=4 G=3.7	Sol. in HCl. F=dif.
1.642	1.669	1.667	Uranophane $CaO.2UO_3.2SiO_2.6H_2O$	32° $\rho<v$ marked.	X nearly ⊥ flat face. $Z\wedge c=2°$. X near *a*.	Tric.(?) Fib. *c*.	{100}	Yellow	H=2 to 3 G=3.8 to 3.96	Gelat. Infus. Pleoc.: X=nearly colorless, Y=pale canary-yellow, Z=canary-yellow. Abnormal blue interference color.
1.635	1.702	1.668	Symplesite $3FeO.As_2O_5.8H_2O$	87° $\rho>v$ rather strong.	X=*b*. $Z\wedge c=32°$.	Mon. Pris. *c*.	{010}perf.	Pale indigo, green.	H=2.5 G=2.96	Decpd. by HCl. Infus. Pleoc.: X=deep blue, Y=colorless, Z=yellowish to oil-green.
1.658	1.670	1.669	Zinkosite $ZnO.SO_3$	Small $\rho<v$ strong.	Z=*c*. X=*a* (bisects acute angle of rhombs).	Orth. Rect. or rhomb plates.		White	G=3.7	Alters on exposure to air.
B=weak.		1.670	Crossite $Na_2O.4(Mg,Fe)O.(Fe,Al)_2O_3.8SiO_2$	Variable. $\rho<v$ very strong.	Z=*b*. $Y\wedge c$=small to mod. Disp. strong.	Mon. Pris.*c*.	{110} perf. at 124°.	Bluish black	H=6 G=3.16	Amphibole group. Insol. Fus. Strongly pleoc.: X=bright yellow to nearly colorless, Y=deep blue, Z=deep violet.
B=0.01		1.670	Clinohedrite $CaO.ZnO.SiO_2.H_2O$	Large	Z=*b*. $Y\wedge c=-28°$.	Mon.	{010}perf.	Colorless, etc	H=5.5 G=3.33	Gelat. F=4.
1.65	1.67	1.67	Strigovite $2(Fe,Mn)O.(Fe,Al)_2O_3.2SiO_2.2H_2O$	0±	X=*c*	Mon. Hex. plates {001}, fib.	{001}mic.	Dark green	H=1 G=3.14	Chlorite group. Pleoc. intense: X=pale greenish, Y and Z=nearly opaque.
1.526	1.672	1.671	Bromlite $(Ca,Ba,Sr)O.CO_2$	7° $\rho>v$ weak.	X=*c*. Z=*b*.	Orth. Elong. *c*.	{110}poor	Colorless	H=4 to 4.5 G=3.71	Effervesces in HCl. Mineral with CaO=17.6, BaO=48.54, SrO=4.25, CO_2=29.41.
1.634	1.685	1.673	Durangite $Na_2O.2AlFO.As_2O_5$	45° $\rho<v$ weak.	Y=*b*. $X\wedge c=25°$. Disp. dist.	Mon.	{110}dist.	Orange-red	H=5 G=3.94 to 4.07	Decpd. by H_2SO_4. F=2. Pleoc.: X=orange-yellow, Y=very pale orange, Z=colorless.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.661	1.683	1.673	Hornblende. Silicate of Al, Fe, Mg, Ca, Na.	84°±. $\rho<v$ weak.	$Y=b$. $Z\wedge c=15°$ to 25°.	Mon. Pris. c.	{110} at 124° perf.	Green to black	$H=6$ $G=3.3\pm$	Amphibole group. Insol. in acid. F=3 to 4. Pleoc. in green and brown. Abs.: $X<Y<Z$.
1.640	1.679	1,674	Spurrite. $5CaO.CO_2.2SiO_2$	39½°. $\rho>v$ weak.	$X=b$. $Z\wedge a=$ nearly 0. Disp. dist.	Mon.(?).	{001} good. {100} at 79°.	Colorless.	$H=5$ $G=3.01$	Sol. in HCl with effervescence and gelat. Infus. Tw. {001} and orthodome at 57, polysynthetic.
1.529	1.677	1.676	Witherite. $BaO.CO_2$	16°. $\rho>v$ weak.	$X=c$. $Z=a$.	Orth. Elong. c	{010} dist. {110} imperf.	do.	$H=3$ $G=4.3$	Sol. in dilute HCl. F=2.5 to 3.
1.665	1.677	1.676	Kornerupine. $6(Mg,Na_2,K_2,H_2)O.$ $4(Al,Fe)_2O_3.5SiO_2$	20°±. $\rho>v$ weak.	$X=c$. $Z=b$.	Orth. Pris. c.	{110} rather perf.	Black.	$H=6.5$ $G=3.27$	Near prismatine. Insol. in acid. F=dif. Pleoc.: X=wine-yellow, Y=brownish yellow, Z=greenish. Kornerupine is colorless.
1.643	1,684	1.678	Childrenite. $2FeO.Al_2O_3.P_2O_5.$ $4H_2O$	45°. $\rho>v$ strong.	$X=b$. $Z=c$.	Orth. Pyram.	{100} perf.	White to brownish.	$H=5$ $G=3.20$	Sol. in HCl. F=4.
B=strong			Erythrosiderite. $2KCl.FeCl_3.H_2O$	2E=130°. $\rho<v$ very strong.	$X=a$. $Z=b$.	Orth. Tab. {100}.				In section yellow. Deliquescent.
B=0.05		1.68	Annabergite. $4NiO.As_2O_5.8H_2O$	90°±.	$X=b$. $Z\wedge$length=0±.	Mon. Capillary crystals.	{010}.	Apple-green.	$H=2.5$ $G=3.10$	Sol. in HCl. F=4.
1.667	1.683	1.681	Cenosite. $2CaO.(Y,Er)_2O_3.$ $CO_2.4SiO_2.2H_2O$	Medium.		Orth. Ps. hex.	One.	Yellowish brown.	$H=5.5$ $G=3.34$ to 3.40	Sol. in hot acid. F=dif. In section brown and nonpleoc.
1.531	1.686	1.682	Aragonite. $CaO.CO_2$	19°. $\rho<v$ small.	$X=c$. $Z=b$.	Orth. Acic. c.	{010} dist.	Colorless.	$H=4$ $G=2.94$	Sol. in dilute acid. Stains red when boiled with solution of $CoNO_3$. (Calcite does not.) Infus.
1.525	1.686	1.684	Barytocalcite. $BaO.CaO.2CO_2$	15°. $\rho>v$ small.	$Z=b$. $X\wedge c=64.4°$.	Mon. Elong. c.	{110} perf. {001} less so.	do.	$H=4$ $G=3.65$	Sol. in HCl. F=dif.

1.678	1.688	1.685	Axinite $6(Ca,Fe,Mn)O.2Al_2O_3.B_2O_3.8SiO_2.H_2O$	71°± $\rho<v$.	X=nearly ⊥{111}. On {111} ext. to {110} 10° and to {111} 24.7°. Disp. perc.	Tric.	{001}{1$\bar{3}$0} {010}dist.	Colorless, pinkish, brown, plum-blue.	H=7 G=3.3	Insol. in acid. F=2.
1.658	1.690	1.635	Schroeckingerite Hydrous uranium carbonate.	40° to 60° $\rho>v$ very strong. Crossed very strong.	X=*b*. Z∧elong. varies greatly with color of light.	Mon. Laths {010}.		Green-yellow	Soft	Pleoc.: X=colorless, Y and Z=canary yellow. Very abnormal interference colors and no extinction *in white light on face.* {010}. Poly. tw. {100}(?).
1.610	1.704	1.685	Roscoelite $2K_2O.2Al_2O_3.(Mg,Fe)O.3V_2O_3.10SiO_2.4\pm H_2O$	Medium $\rho>v$ strong.	Y=*b*. X∧*c*=0 to 4°.	Mon. Plates {001}.	{001}mic.	Green	H=3 G=2.97	Mica group. Insol. in acid. F=3(?). Pleoc.: X=olive-green, Z=green brown. Apple-green interference color is characteristic.
1.67	1.698	1.686	Trichalcite $3CuO.As_2O_5.5H_2O$	Large	X⊥plates. Y // length.	Orth. Plates.		Verdegris green.	H=2.5	Easily sol. in HCl. F=2 to 2.5. In section pale bluish green and non-pleoc.
1.678	1.689	1.686	Dumortierite $8Al_2O_3.B_2O_3.6SiO_2.H_2O$	30° to 40° $\rho<v$.	X∧*c*=0°± Z=*a*.	Orth. Acic. *c*.	{100}dist.	Blue, greenish, reddish violet.	H=7 G=3.3	Insol. in acid. Infus. Pleoc.: X=deep blue or violet, Y=yellow to red violet or nearly colorless, Z=colorless or very pale blue.
1.630	1.739	1.689	Zippeite $2UO_3.SO_3.4H_2O$	Large. Disp. slight.	X=*b*. Z∧*c*=32° to 41°.	Mon.(?) Laths {010}. Elong. *c*.	{010}perf.(?)	Orange-yellow, etc.	H=3	Sol. in acid. Pleoc.: X=nearly colorless, Y=rather deep yellow, Z=deep yellow.
1.60	1.69±	1.69±	Stilpnomelane $2(Fe,Mg)O.(Fe,Al)_2O_3.5SiO_2.3H_2O$	0°±	X=*c*	Mon. Plates.	{001}mic.	Black	H=3 to 4 G=2.71 to 3.4	Chlorite group. Chalcodite. Decpd. by HCl. F=4.5. Strongly pleoc.: X=yellowish, Y and Z=dark brown and nearly opaque.
B=weak		1.69	Hastingsite Silicate of Fe,Al,Mg, Ca,Na.	12°	Y=*b*. Z∧*c*=25° to 30°.	Mon. Pris. *c*.	{110} perf. at 124°.	Blue-green	H=6 G=3.2	Amphibole group. Pleoc.: X=yellow-green, Y and Z=deep blue-green.
B=0.005		1.693	Pharmacosiderite $3Fe_2O_3.2As_2O_5.13H_2O$	Large $\rho>v$ very strong.	Ext. large. Y=*b*(?). Disp. strong.	Mon.(?) Ps. isomet. Cubic.	{100}imperf.	Olive-green, brown, yellow.	H=2.5 G=2.9 to 3.0	Sol. in HCl. F=1.5 to 2. Divided into cubic segments and these show poly. tw. Abnormal interference colors.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.676	1.708	1.694	Kaersutite Titaniferous hornblende.	82° Disp. weak.	On{110}$Z\wedge c$=8°.	Mon. Pris. *c*.	{110} perf. at 124°.	Black	H=6 G=3.14	Amphibole group. Fus. readily to a black magnetic bead. Pleoc.: X=light brown, Y=dark reddish brown, Z=darker reddish brown.
B=low		1.695	Riebeckite $Na_2O.FeO.Fe_2O_3.5SiO_2$	Large	X=*b* $Z\wedge c=4°$.	Mon. Fib. *c*.	do	Black, blue.	H=4 G=3.2 to 3.3	Amphibole group. Insol. in acid. F=3(?). Pleoc.: X=deep blue to smoky green, Y=yellowish to brownish yellow, Z=very dark smoky green to black.
1.677	1.708	1.695	Basaltic hornblende Silicate of Fe, Al, Mg, Ca, Na.	Large $\rho<v$.	Y=*b* $Z\wedge c$=0 to 10° ±.	Mon. Pris. *c*.	do	Brownish black, etc.	H=6 G=3.4	Amphibole group. Insol. in acid. Fus. Pleoc.: X=yellow, Y and Z=dark brown or green.
1.672	1.717	1.697	Gruenerite $FeO.SiO_2$	82° $\rho<v$.	Y=*b* Ext. {010}=10° to 11°. Disp. weak.	Mon. {110} Pris. *c*. Tetrag.	do	Black	H=6 G=3.5	Amphibole group. Fus. to a black magnetic globule, Pleoc.: X and Y=colorless, Z=pale yellow to brownish. Poly. tw. {100}. Data for mineral with percentages of $FeSiO_3$=91, $MgSiO_3$=5, Na_2SiO_3=3, K_2SiO_3=1.
1.687	1.708	1.70	Arfvedsonite Silicate of Fe, Na, Al, Ca, Mg.	Large	Y=*b* $X\wedge c=-12°$ to 15°.	Mon. Pris. *c*.	do	do	H=6 G=3.45	Amphibole group. Insol. in acid. F=2. Pleoc.: X=greenish blue, Y=lavender blue, Z=green yellow.
B=mod.		1.702	Triphylite $Li_2O.2FeO.P_2O_5$	0 to 34° $\rho>v$ very strong.	X=*c* Z=*b*.	Orth	{001} perf {010} nearly perf. {110} interrupted.	Greenish gray, bluish.	H=5 G=3.55	Isomor. with lithiophilite, which is opt.+ and has a lower *n*. Sol. in acid. F=1.5.

1.692	1.705	1.702	Hypersthene $(Mg,Fe)O.SiO_2$	72° $\rho>v$.	X=*a*. Z=*c*.	Orth. Pris. *c*.	{110}perf. at 90°	Greenish	H=5.5 G=3.5	Pyroxene group. Isomor. with enstatite. Nearly insol. in acid. F=5. Data for mineral with FeO=22.6 per cent. As iron increases B increases, 2V decreases, pleoc. increases. Pleoc.: X=clear red, Y=yellow, Z=green.
1.660	1.713	1.705	Tarbuttite $4ZnO.P_2O_5.H_2O$	50° One bar indicates $\rho>v$ weak. The other $\rho<v$.	Ext. on {010} 25° with {100} and 10° with {001}. Ext. {100} 26° with {001} and 14° with {010}. Disp. strong.	Tric.	{001}perf.	Colorless, yellowish, brownish.	H=4 G=4.15	Sol. in dil. HCl. F=easy.
1.687	1.708	1.707	Barkevikite Between hornblende and arfvedsonite.	54°	X=*b*. $Z\wedge c=12°$ to 14°.	Mon. Fib. *c*.	{110} perf. at 124°.		H=6 G=3.43	Amphibole group. Pleoc.: X=bright brownish yellow, Y=reddish brown, Z=deep brown.
1.705	1.711	1.709	Sapphirine $5MgO.6Al_2O_3.2SiO_2$	69° $\rho<v$.	Y=*b*. $Z\wedge c=-8.5°$. Disp. perc.	Mon. Tab. {010}.	None	Pale blue, green.	H=7.5 G=3.45	Insol. in acids. Infus. Pleoc.: X=light greenish blue, Y=blue, Z=blue or X=light greenish blue, Y=dark pure green, Z=yellow, faded green.
1.660	1.760	1.710	Zippeite(?) $UO_3.SO_3.6H_2O$	Large Slight.	X=*b*. $Z\wedge c=40°$.	Mon. Laths {010}. Elong. *c*.	{010}perf.(?)	Apricot, yellow	H=3	Pleoc.: X=colorless, Y=pale orange-yellow, Z=deep orange-yellow.
1.703	1.722	1.713	Gerhardtite $4CuO.N_2O_5.3H_2O$	Large $\rho<v$ very strong.	X=*c*. Z=*a*.	Orth. Striated horizontally.	{001}highly perf. {100} less so.	Emerald-green	H=2 G=3.43	Sol. in dil. acids. F=2. Pleoc.: X and Y=green, Z=blue.
1.697	1.722	1.714	Strengite (manganiferous). $(Fe,Mn)_2O_3.P_2O_5.4H_2O$	Medium Disp. strong.		Orth		Blue	H=3 to 4 G=2.8	Sol. in HCl. F=2.5 to 3. Pleoc.: X=very pale violet, Y=violet, Z=deep blue.
1.700	1.726	1.716	Woehlerite $10CaO.Na_2O.10SiO_2.3ZrO_2.Cb_2O_5.3NaF$	71° to 79° $\rho<v$ dist.	Z=*b*. $X\wedge c=-45°\pm$.	Mon. Tab. {100}.	{010}dist.	Light yellow, brown.	H=6 G=3.42	Pyroxene group. Sol. in HCl. F=3 to 3.5. Pleoc. weak: X and Y=light wine-yellow, Z=deep wine-yellow.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.716	1.723	1.719	Clinozoisite $4CaO.3Al_2O_3.6SiO_2.H_2O$	81° to 90° $\rho>v$ strong.	Y=*b*. $Z\wedge c=2°$.	Mon. Elong. *b*.	{001}perf.	Colorless.	H=7 G=3.36	Epidote group. Insol. in HCl. F=3 to 4.
1.715	1.720	1.719	Vesuvianite $12CaO.3Al_2O_3.10SiO_2.H_2O$	30 to 60°		Tetrag.	{110}poor.		H=6.5 G=3.4	Partly decpd. by HCl. F=3. Anom. biax. Pleoc. slight.
1.715	1.725	1.720	Trimerite $(Mn,Ca)O.GlO.SiO_2$	83°	Axial pl. and X nearly ⊥ {0001}.	Tric. Ps. hex. Thick tablets {0001}.	{0001}dist.	Colorless.	H=6 G=3.47	Sol. in HCl. F=dif. Basal section shows three radial segments.
1.712	1.728	1.720	Cyanite $Al_2O_3.SiO_2$	82° $\rho>v$ slight.	X=almost ⊥ {100}. Ext. on {100} $Z\wedge c=-30°\pm$. Disp. dist.	Tric. Blades {100}. Elong. *c*.	{100}very perf. {010} less so. {001}parting.	Blue.	H=4 to 7 G=3.6	Insol. in acid. Infus. Pleoc. faint: X=colorless, Y=violet blue, Z=cobalt-blue. (1) Tw. pl. composition face {100}; (2) tw. axes {100} {001}; composition face {100}; (3) tw. and composition pl. {001} poly., etc.
1.691	1.720	1.720	Phosphuranylite $3UO_3.P_2O_5.6H_2O$	0± $\rho \gtrless v$ very strong.	X=*b*. Disp. strong.	Mon. (?) Plates {010}.		Deep lemon-yellow.		Sol. in HCl. F=3 (?). Pleoc. strong: X=nearly colorless, Y and Z=canary-yellow.
1.686	1.735	1.722	Glaucochroite $CaO.MnO.SiO_2$	61° $\rho>v$ marked	X=*b*. Z=*a*.	Orth. Pris. *c*.		Bluish green	H=6 G=3.41	Easily sol. in HCl. F=3.
1.680	1.752	1.725	Basaltic hornblende Silicate of Fe, Al, Mg, Ca, Na.	79°± $\rho<v$.	Y=*b*. $Z\wedge c=0$ to 10°.	Mon. Pris. *c*.	{110} perf. at 124°.	Brownish black.	H=6 G=3.4	Amphibole group. Insol. in acid. Fus. Pleoc.: X=yellow, Y and Z=dark brown or green.
1.694	1.730	1.726	Tyrolite $5CuO.As_2O_5.9H_2O$	36° $\rho>v$ strong.	X=*c*. Z=*a*.	Orth. Laths {001}, elong. *b*. Fan-shaped aggregates.	{001}perf.	Pale green, sky blue.	H=1 to 1.5 G=3.02 to 3.10	Sol. in HNO_3 or NH_4OH. F=2 to 2.5. Pleoc.: X=grass-green, Y=yellowish green, Z=grass-green.
1.711	1.740	1.727	Picrotephroite $2(Mn,Mg)O.SiO_2$	85° $\rho>v$.	X=*b*. Z=*a*.	Orth. Equant.	{010} dist.	Red, brown	H=6 G=4.0	Olivine group. Gelat. F=3 to 4. Data for mineral with percentages of Mg_2SiO_4=40.4; Mn_2SiO_4=59.6.

1.705	1.730	1.729	Ganophyllite $6H_2O.7MnO.Al_2O_3.8SiO_2$	24° $\rho<\nu$ weak.	$X \wedge c$=small. Y=*b*.	Mon. Tab. {001}.	{001} mic.	Brown	H=4 G=2.84	Gelat. F=3. Pleoc.: X=yellow-brown, Y and Z=colorless.
B=0.056	....	1.73	Gruenerite $FeO.SiO_2$	50° $\rho>\nu$.	Y=*b* $Z \wedge c$=11° to 15°.	Mon. Pris. *c*. Fib.	{110} perf. at 124°.	....do	H=6 G=3.5	Amphibole group. F to a black, magnetic glass. Pleoc.: X and Y=colorless, Z=yellow to brown. Tw. pl. {100} polysynthetic.
1.692	1.760	1.730	Kaersutite Titaniferous hornblende.	80° Weak.	On {110}. $Z \wedge c$=1°.	Mon. Pris. *c*.	{110} perf. at 124°.	Black	H=6 G=3.34	Amphibole group. F=readily to a black magnetic bead. Pleoc.: X=pale olive-brown or olive-green, Y=brown, Z=dark brown, almost opaque.
1.710	1.732	1.731	Chalcomenite $CuO.SeO_2.2H_2O$	$34°_{Li}$ $\rho>\nu$ ext.	Y=*b*	Mon.		Blue	H=2.5 to 3 G=3.76	F=1.5. In section pale greenish blue and nonpleoc.
1.723	1.736	1.734	Gageite $8(Mn,Mg,Zn)O.3SiO_2.2H_2O$	Med. $\rho<\nu$ ext.	Z=*c*	Orth.(?) Acic. *c*.		Colorless		Sol. in HCl. Infus.
1.708	1.758	1.734	Adamite $4ZnO.As_2O_5.H_2O$	90°± $\rho>\nu$ strong.	Z=*b* X=*a*.	Orth. Elong. *b*.	{010} discontinuous.	Yellow, green, colorless, etc.	H=3.5 G=4.35	Sol. in HCl. F=3.
1.715	1.75	1.735	Hodgkinsonite $3(Zn,Mn)O.SiO_2.H_2O$	Medium large. $\rho>\nu$ rather strong.	Z emerges from cleav. plate.	Mon. Pyram.	{001} perf.	Pink to pale reddish brown.	H=5 G=3.91	Gelat. Fus. readily to a brown enamel.
1.715	1.745	1.735	Sicklerite $6MnO.Fe_2O_3.4P_2O_5.3(Li,H)_2O$	Medium large. $\rho>\nu$ very strong.	Z ⊥ best cleav.	Orth.(?)	Two unequal at 90°.	Dark brown, etc.	H=4 G=3.45	Sol. in acid. Fus. easily. Pleoc.: Yellow to orange-red. Abs.: X>Y>Z.
1.640	1.750	1.736	Hydrozincite $5ZnO.2CO_2.3H_2O$	40° $\rho<\nu$ rather strong.	X=*b* $Z \wedge c$=mod.	Mon.(?) Fib. *c*. Laths {100}.	{100} perf.	White, gray, yellow.	H=2 to 2.5 G=3.6 to 3.8	Sol. in HCl. Infus.
1.731	1.744	1.738	Thalenite $2Y_2O_3.4SiO_2.H_2O$	68°	Z=*b* $Y \wedge c$=small.	Mon. Tab. {100}.	None	Pink	H=6.5 G=4.23	
1.727	1.751	1.739	Allanite (altered) $4(Ca,Fe)O.3(Al,Ce,Fe,Di)_2O_3.6SiO_2.H_2O$	Medium large. $\rho>\nu$ rather strong.	Y=*b*	Mon.	{001} {110}. {110} imperf.	Brown, black.	H=6 G=3.5 to 4.2	Epidote group. May gelat. F=3. Pleoc.: X=pale yellowish or pale greenish, Y and Z=brownish red or green.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.733	1.744	1.740	Rhodonite $MnO.SiO_2$	Large $\rho<\upsilon$ weak.	On {100}$Z'\wedge c$ $=32°\pm$. On {010}$Z'\wedge c$ $=10°\pm$.	Tric. Tab. {001}.	{110}{1̄10} perf. {001} less so.	Red, etc.	H=6 G=3.67	Pyroxene group. Nearly insol. in acid. F=2.5.
B=rather strong.	....	1.74	Vilateite $Mn_2O_3.P_2O_5.4H_2O$	$\rho>\upsilon$ strong	Ext. small	Mon	....	Violet, etc.	H=3 G=2.75	Manganese strengite. Compare with blue strengite. Pleoc. slight; rose tint // c.
	....	1.74±	Tarapacaite $K_2O.CrO_3$	52° $\rho>\upsilon$ weak.	X=*b*. Z=*c*.	Orth	{010}{001} fair.	Yellow	G=2.74	β=1.713 (C), 1.715 (B), 1.770 (F).
1.655	1.744	1.740	Aurichalcite $5(Zn,Cu)O.2CO_2.3H_2O$	Very small $\rho<\upsilon$ strong.	Y near *a* Z near elong.	Tric. (?) Plates {100} Fib. *c*.	{100} mic.	Pale green or blue.	H=2 G=3.54 to 3.64	Sol. in acid. Infus. Pleoc.: X=nearly colorless, Y and Z=pale greenish.
1.71	1.76	1.74	Iddingsite $2Fe_2O_3.2SiO_2.3H_2O$	Large $\rho<\upsilon$ strong.	X ⊥ plates	Pseudomorph after olivine.	Mic	Reddish brown.	H=2.5 G=2.8	Decpd. by HCl. Infus. Pleoc. in brown and yellow. Abs.: X<Y<Z.
1.702	1.789	1.745	Libethenite $4CuO.P_2O_5.H_2O$	85° $\rho>\upsilon$ strong.	X=*b*. Y=*c*.	Orth Elong. *c*.	{100}{010} poor.	Olive-green	H=4 G=3.7	Sol. in acid. F=2 to 2.5. Pleoc.: X=pale green to yellow, Y=bright green to greenish yellow, Z=yellow to yellowish green.
B=0.03	....	1.750	Lavenite $(Mn_2,Zr,Ca_2,Na_4)O_2.(Si,Zr)O_2$	80° Disp. weak.	Y=*b*. $X\wedge c=-20°$.	Mon Tab. {100}.	{100} good	Yellow to brown, colorless.	H=6 G=3.5	Pyroxene group. Difficultly sol. in HCl. Fus. Tw. pl. {100} lamellar. Pleoc.: X=colorless to clear wine-yellow, Y=colorless to greenish yellow, Z=golden or brownish-yellow to orange-red.
1.729	1.768	1.754	Epidote $4CaO.3(Al,Fe)_2O_3.6SiO_2.H_2O$	Large $\rho>\upsilon$ rather strong.	Y=*b*. $X\wedge c=-2.5°$.	Mon Elong. *b*.	{001} perf. {100} imperf.	Pistachio-green.	H=6 G=3.4	Epidote group. Partly decpd. by HCl. F=3 to 4. Pleoc.: X=colorless, Y=pale greenish yellow, Z=colorless, etc.

1.743	1.764	1.754	Caracolite $Na_2O.SO_3.$ $Pb(OH)Cl$	Nearly 90° $\rho>v$ rather strong.		Orth	None	Colorless	H=4.5	Somewhat sol. in hot dilute HCl. F=1.5 to 2. Complex tw. or similar structure.
1.708	1.798	1.760	Langite $4CuO.SO_3.4H_2O$	81°	X=*c*. Z=*a*.	Orth Laths {010} elong. *a*. Fib.	{001} very perf. {010}.	Blue to greenish blue.	H=2.5 to 3 G=3.49	Sol. in HCl. F=3.5. Pleoc. faint in pale blue. Abs.: X<Y and Z.
1.719	1.805	1.762	Dihydrite $5CuO.P_2O_5.2H_2O$	90°± $\rho>v$ strong.	X∧c=22° Z near *b*.	Mon. or tric. Crystals, crusts, fibers.	{010} imperf.	Dark emerald-green.	H=4.5 to 5 G=4.0 to 4.4	Sol. in HCl. F=2 to 2.5. Pleoc. faint. X=bluish green, Y=yellowish green, Z=deep bluish green.
1.760	1.768	1.768	Corundum Al_2O_3	0 to 32°		Trig. Anom. biax.	{0001} perf. parting.	Red, blue, etc.	H=9 G=4.0	Insol. in acid. Infus. Pleoc. faint.
1.745	1.782	1.770	Aegirite (vanadiferous). $Na_2O.(Fe,V)_2O_3.4SiO_2$ Some $CaO.MgO.2SiO_2$	69° $\rho>v$ strong.	X∧c=1.4°	Mon. Pris. *c*.	{110} perf. at 89°.	Brownish black.	H=6 G=3.55	Pyroxene group. Compare with acmite. Insol. in acid. F=3.5. Pleoc.: X=dark brown, Y=light brown, Z=pale yellowish brown.
1.751	1.782	1.771	Leucophoenicite $7(Mn,Zn,Ca)O.3SiO_2.H_2O$	74° $\rho>v$ slight.	X ⊥ cleav.	Mon. Massive.	One imperf.	Light purplish red.	H=6 G=3.85	Gelat. F=3. Pleoc. slight in pale rose to colorless.
1.729	1.807	1.773	Margarosanite $PbO.2(Ca,Mn)O.3SiO_2$	83° $\rho<v$ perc.	Tablets give ext. X′∧, cleav.=44°.	Tric. Lamellar.	One very perf. // tablets. Two others at nearly right angle to tablets, giving rhombic tablets with angle of 78°.		H=2.5 to 3 G=3.99	F=dif. in oxidizing flame. F=2 in reducing flame.
1.730	1.803	1.778	Brochantite $4CuO.SO_3.3H_2O$	72° $\rho<v$ rather strong.	X=*b*. Z=*c*.	Orth Pris. *c*.	{010} perf.	Emerald-green	H=4 G=3.8 to 3.9	Sol. in acid. F=3.5. In section emerald-green and nonpleoc.
1.760	1.779	1.779	Allactite $7MnO.As_2O_5.4H_2O$	$4°_{Na}$ 0 for green. $\rho>v$ very strong.	For red and yellow Z=*b* and X∧*c*=49.2°. For blue Y=*b*.[a]	Mon. Pris. *c*.	{101} dist. {100} less so.	Brownish-red.	H=4.5 G=3.84	Easily sol. F=2(?). Pleoc. weak in hyacinth-red and olive-green. Nearly colorless in section.
1.757	1.803	1.78	Thortveitite $(Sc,Y)_2O_3.2SiO_2$	80°	X=*c*. Z=*a*.	Orth Pris. Radial rosettes.	{110} good.	Grayish green.	H=6 to 7 G=3.57	Near thalenite. Slowly sol. in acid. F=easy. Tw. pl. {110}.

[a] Krenner, J., Beitrag zur Kenntniss der optischen Verhältnisse des Allaktites: Zeitschr. Kryst. Min., vol. 10, pp. 83–84, 1885. Dana and others quote Krenner incorrectly.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.65	1.78	1.78	Stilpnomelane $2(Fe, Mg)O.(Fe, Al)_2O_3.5SiO_2.3H_2O$	0±	X=*c*	Mon. (?) Hex. plates.	{001} mic.	Black	H=3 to 4 G=2.71 to 3.4	Chlorite group. Decpd. by HCl. F=4.5. Strongly pleoc.: X=yellowish, Y and Z=dark brown and nearly opaque.
1.758	1.804	1.786	Roepperite $2(Mn,Fe,Zn)O.SiO_2$	77± ρ>υ rather strong.	X=*b*. Z=*c*.	Orth Equant.	{010} dist. {001} dist.		H=5.5 to 6 G=3.95 to 4.10	Olivine group. Gelat. Fus. easy.
1.759	1.797	1.786	Tephroite $2MnO.SiO_2$	65° ρ>υ perc.	X=*b*. Z=*a*.	Orth Equant.	{010} dist.	Red, brown, gray, etc.	H=6 G=4.1	Olivine group. Gelat. F=3.5. Pleoc. faint: X=brownish-red, Y=reddish, Z=greenish-blue. Data for mineral with 7.8 per cent of Mg_2SiO_4.
1.747	1.829	1.788	Olivenite $4CuO.As_2O_5.H_2O$	90°± ρ<υ strong.	X=*b*. Z=*a*.	Orth Pris. *c*, acic. *c*.	Traces	Olive-green to dark yellow-brown.	H=3 G=4.1 to 4.4	Sol. in HCl. F=2 to 2.5. In large part opt. +. In section pale green and nonpleoc.
1.768	1.803	1.792	Hortonolite $2(Fe, Mg, Mn)O.SiO_2$	69° ρ>υ.	X=*b*. Z=*a*.	Orth Equant.	{010}	Yellow, yellow-green, black.	H=6.5 G=3.91	Olivine group. Gelat. F=4.5. Pleoc. faint: Y=orange-yellow, X and Z=green-yellow.
1.780	1.802	1.793	Sarkinite $4MnO.As_2O_5.H_2O$	83° Disp. weak.	Y=*b*. X∧*c*=−54°.	Mon Pris. *b*.	Pris. dist.	Rose red, etc.	H=4 to 4.5 G=4.18	Easily sol. in HCl. F=4.
1.763	1.813	1.799	Aegirite $Na_2O.Fe_2O_3.4SiO_2$	62° ρ>υ dist.	Y=*b*. X∧*c*=2° to 5°. Disp. perc.	Mon Pris. *c*.	{110} perf. at 90°.	Green, brown, black.	H=6 G=3.5	Acmite. Pyroxene group. Nearly insol. F=2. Tw. pl. {100} common. Pleoc. X=greenish to dark brown, or dark grass-green, Y=yellow to greenish yellow or olive-green, Z=greenish to brown-yellow or yellowish-green.
B=strong		1.80	Cronstedtite $5(Fe, Mg)O.Fe_2O_3.2SiO_2.3H_2O$	0±	X=*c*	Tapering hex. prisms.	{001} mic.	Black	H=3.5 G=3.34	Chlorite group. Gelat. F=4. Pleoc. marked in dark brown to nearly opaque.

1.788	1.830	1.81	Hancockite $4(Pb, Ca, Sr)O.$ $3(Al, Fe, Mn)_2O_3.$ $6SiO_2.H_2O$	50° $\rho > v$ perc.	Y=*b*	Mon.	{001}	Brownish-red.	H=6 to 7 G=4.03	Epidote group. Gelat. in acid after ignition. F=3. Pleoc. in reddish brown. Abs.: Z>X.
1.775	1.825	1.815	Pascoite $3V_2O_5.2CaO.11H_2O$	50° $\rho > v$ very strong.	Y in (010) Disp. ext.	Mon. —	{010} poor(?)	Red-orange to yellow-orange.	H=2½ G=2.46	Readily sol. in H_2O. Pleoc.: X=light cadmium-yellow, Y=cadmium-yellow, Z=orange.
1.715	1.820	1.817	Jarosite $K_2O.3Fe_2O_3.4SO_3.$ $6H_2O$	Very small	X=*c* Opt. pl. // edge.	Orth. Hex. tablets and fibers.	{0001} dist.	Ocher-yellow, brown.	H=3 G=3.2	Alunite group. Sol. in HCl. F=4.5. Basal section divided into six segments. Faintly pleoc.: X=nearly colorless, Y and Z=pale yellowish.
1.800	1.846	1.831	Higgensite $2CuO.2CaO.As_2O_5.$ H_2O	Near 90° $\rho > v$ rather strong.	X=*a* Y=*b*.	Orth. Stout prisms.		Malachite to yellow-green.	H=4.5 G=4.33	Sol. in acid. F=3. Pleoc.: X=green, Y=yellow-green, Z=blue-green.
1.750	1.832	1.832	Natrojarosite $Na_2O.3Fe_2O_3.4SO_3.$ $6H_2O$	Very small	X=*c*	Orth. Hex. tablets.	{0001} perf.	Yellow, brown	H=3 G=3.2	Alunite group. Sol. in HCl. F=3. Faintly pleoc.: X=nearly colorless, Y and Z=pale yellowish.
1.805	1.847	1.838	Knebelite $2(Fe,Mn,Mg)O.$ SiO_2	54° $\rho < v$ mod.	X=*a* Z=*b*.	Orth. Equant.	{110} dist.	Gray, etc.	H=6.5 G=3.9 to 4.17	Olivine group. Gelat. F=3. Data for mineral with percentages of Mg_2SiO_4=7.5 per cent, Mn_2SiO_4=26.7; Fe_2SiO_4=65.8.
1.809	1.859	1.838	Linarite $5PbO.2CuO.3SO_3.$ $CO_2.3H_2O$	80° $\rho < v$ marked.	Z=*b* $X \wedge a = -24°$.	Mon. Tab. {001} or elong. *b*.	{100} very perf. {001} less so.	Deep sky-blue.	H=2.5 G=5.4	Partly sol. in HNO_3. F=1.5.
B=0.05±		1.84±	Dufrenite $2Fe_2O_3.P_2O_5.3H_2O$	Large $\rho < v$ extr.	Z=*b* X=fibers. Disp. extr.	Mon. Fib.	{010} perf.	Dull leek-green	H=3.5 to 4 G=3.2 to 3.4	Sol. in acid. F=2.5. Pleoc. strong: X=bright green, Y=pale yellowish, Z=dark reddish brown.
1.69	1.85	1.84	Tagilite $4CuO.P_2O_5.3H_2O$	Small	Elong. —	Mon. Concretionary.	{010} dist.	Green	H=3 to 4 G=4.08	Sol. in acid. F=2 to 2.5.
1.773	1.845	1.840	Chalcosiderite $CuO.3Fe_2O_3.2P_2O_5.$ $8H_2O$	24° $\rho > v$ very strong.	X near *b* Disp. strong.	Tric. Sheaf-like aggregates.	{010} easy	Siskin-green	H=4.5 G=3.11	Sol. in HCl. F=4 to 4.5 Pleoc. in thick sections: X = colorless, Z = pale green. Section {010} gives no extinction in white light but very abnormal red, blue, and green interference colors.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.825	1.857	1.842	Dietzeite $15CaO.7I_2O_5.8CrO_3$	86° $\rho<v$ very strong.	Y=*b* Ext.{010}=6° Disp. marked.	Mon Tab. {100}. Elong. *c*.	{100} imperf.	Dark golden yellow.	H=3 to 4 G=3.70	Sol. in hot H_2O, with separation of $CaIO_3$ on cooling. F=1.5.
1.820	1.88	1.826	Erinite $5CuO.As_2O_5.2H_2O$	Small $\rho<v$ mod.	Z ⊥ cleav. Y // elong.	Fib.	One perf.	Emerald-green	H=5 G=4.04	F=2 to 2.5.
1.831	1.880	1.861	Atacamite $3CuO.CuCl_2.3H_2O$	75° $\rho<v$ strong.	X=*b* Z=*c*.	Orth Slender prisms *c*.	{010} highly perf. {101} imperf.	Green, streak green.	H=3 G=3.78	Sol. in acid. F=3 to 4. Tw. pl. {110}. Pleoc.: X=pale green, Y=yellow-green, Z=grass-green.
1.818	1.909	1.866	Caledonite $2(Pb,Cu)O.SO_3.H_2O$	85°± $\rho<v$ slight.	X=*b* Z=*c*.	Orth. Pris. *a*.	{001} perf. {100} less so.	Bluish green	H=3 G=6.4	Sol. in part in HNO_3. F=1.5. Pleoc.
1.73	1.91	1.870	Clinoclasite $6CuO.As_2O_5.3H_2O$	53° $\rho>v$ very strong.	Y=*b* Z near *a*. Disp. small.	Mon.	{001} highly perf.	Blackish blue-green.	H=3 G=4.19 to 4.38	F=2 to 2.5. Pleoc.: X=pale blue-green, Y=light blue-green, Z=benzol-green.
1.670	1.895	1.870±	Tyuyamunite $CaO.2UO_3.V_2O_5.8\pm H_2O$	36° $\rho>v$ rather strong.	X=*c* Y bisects acute angle of rhombs or // length.	Orth. Plates {001}. Elongated or rhombic.	{001} mic.	Yellow	Soft.	Pleoc.: X=nearly colorless, Y = canary-yellow, Z = darker canary-yellow.
1.786	1.875	1.875	Plumbojarosite $PbO.3Fe_2O_3.4SO_3.6H_2O$	Small	X ⊥ plates	Ps. trig. Hex. plates.	{10$\bar{1}$1}	Brown	G=3.63	Alunite group. Sol. in HCl. Pleoc.: X=pale golden yellow, Y and Z=dark brownish red. Basal plates divided in hexagonal segments.
1.655	1.909	1.875	Malachite $2CuO.CO_2.H_2O$	43° $\rho<v$ in air.	Y=*b* $X\wedge c=23°$. X nearly ⊥ {001}.	Mon. Pris. *c*.	{001} perf. {010} less so.	Green	H=4 G=4.0	Sol. with effervescence. F=2. Disp. within crystal, $\rho>v$ large. Pleoc.: X=nearly colorless, Y=yellowish green, Z=deep green.

1.835	1.886	1.877	Fayalite $2FeO.SiO_2$	47° $\rho>v$.	X=*b*. Z=*a*.	Orth. Equant.	{010} dist. {100} less so.	Yellow, brown, black.	H=6.5 F=4.34	Olivine group. Gelat. F=4. Pleoc. Nearly colorless in section. Abnormal blue and yellow interference colors. Data for nearly pure Fe_2SiO_4.
B=0.01	....	1.88±	Tscheffkinite (altered) Titanosilicate of Ce, Fe, etc.	Medium	....	Mon.(?)	Conc.	Velvet-black.	H=5 G=4.3 to 4.55	Gelat. F=4. Pleoc.: X=nearly colorless, Y=pale red-brown, Z=rather dark red-brown. In part isotropic.
1.80	1.88	1.88±	Arseniosiderite $3CaO.2Fe_2O_3.2As_2O_5.6H_2O$	0±	X=*c*.	Orth. Pris. or blades{001}	{001}perf.	Yellow to black. Blood-red in splinters.	H=4.5 G=3.57	Sol. in HCl. F=3. Pleoc.: X=nearly colorless, Y and Z=dark reddish brown.
1.86	1.91	1.89±	Heterosite $(Fe,Mn)_2O_3.P_2O_5.H_2O$	Large	X⊥ cleav.	Massive. Lamellar.	Three unequal.	Black. Powder red.	H=5.5 to 6 G=3.52	Sol. in acid. Fuses to a deep brown enamel. Pleoc.: X=gray, brown, reddish brown, Y=brilliant carmine, Z=very dark violet or red.
B=strong	1.91	1.91	Ilvaite $2CaO.4FeO.Fe_2O_3.4SiO_2.H_2O$	Small $\rho<v$ very strong.	Z=*c*. X=*b*.	Orth.	{010}{001}dist.	Brownish black.	H=5.5 to 6 G=3.8 to 4.1.	Gelat. F=2.5. Strongly pleoc. in transmitted light: X and Y=green, nearly opaque, Z=pale yellow brown.
.... 1.750	1.92 1.95	1.895 1.925	Carnotite $K_2O.2UO_3.V_2O_5.8\pm H_2O$	39° to 44° $\rho<v$ weak.	X=*c*. Y bisects acute angle of plates.	Orth. Rhombic plates{001} shreds.	{001}mic.	Yellow	Soft	Colorless to pale yellow in section.
1.77	1.97	1.93±	Tyuyamunite $CaO.2UO_3.V_2O_5.8\pm H_2O$	40° to 55° $\rho<v$ rather strong.	X=*c*. Y bisects acute angle of rhombs or // length.	Orth. Plates{001}, elongated or rhombic.	do	do	Soft	Pleoc.: X=nearly colorless, Y=canary yellow, Z=darker canary yellow.
B=weak.	....	1.93	Corkite $2PbO.3Fe_2O_3.P_2O_5.2SO_3.6H_2O$	....	X=*c*.	Ps. trig. Hex. plates. Cubic.	{0001}easy.	Olive-green, etc.	H=4 G=4.1	Alunite group. Basal section divided into biaxial segments. Abnormal green interference colors.
1.92	1.96	1.95	Manganostibiite $10MnO.Sb_2O_5$	Small	X⊥ cleav. Ext. large.	Mon. Fibers.	One.	Black	....	Sol. in HCl. Infus. Ploec.: X=reddish brown, Z=nearly opaque.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.702	1.965	1.955	Durdenite $Fe_2O_3.3TeO_2.4H_2O$	22° $\rho>\nu$ very strong.	X⊥cleav.	Orth.	One perf.	Greenish yellow.	H=2 to 2.5	Sol. in acid. Fus. Pleoc.: X=nearly colorless, Y=pale yellowish with a greenish tinge, Z=rather pale sulphur-yellow.
B=weak.	....	1.96	Beudantite $2PbO.3Fe_2O_3.As_2O_5.2SO_3.6H_2O$	Med. Disp. abnormal.	X=*c*	Ps.trig. Acute rhombs,etc.	{0001}easy.	Green, brown, black.	H=4 G=4.1	Alunite group. Rather sol. in hot dilute HCl. F=3.5. Base divided into six biax. segments. Abnormal interference colors. Complex twinning.
1.947	1.968	1.961	Alamosite $PbO.SiO_2$	65° $\rho<\nu$ extr.	Y=*b*. Disp. slight.	Mon. Fib. *b*.	{010}perf.	Colorless.	H=4.5 G=6.49	
B=0.02	....	1.97	Tscheffkinite (altered) Titanosilicate of Ce, Fe, etc.	Small.	....	Mon.	Conch.	Velvet-black.	H=5 G=4.3 to 4.55	Gelat. F=4. Pleoc.: X=pale brown, Z=dark red-brown. In part isotropic.
1.871	2.005	1.975	Walpurgite $5Bi_2O_3.3UO_3.2As_2O_5.12H_2O$	52° Disp. slight.	Ext. {100} Y∧*c*=8°.	Tric. Tab. {010}, elong. *c*.	....	Yellow-green, wax-yellow.	H=5 G=5.76	F=1.5 Tw. // tablets.
1.93	2.02	1.99	Lanarkite $2PbO.SO_3$	47° $\rho>\nu$ perc.	Y=*b*.	Mon. Tab. {100}, elong. *b*.	{001}perf.	White, etc.	H=2 to 2.5 G=6.4 to 6.8	Somewhat sol. in hot dilute HCl. F=2.
1.90	2.05±	2.00±	Walpurgite $5Bi_2O_3.3UO_3.2As_2O_5.12H_2O$	Large.	X nearly ⊥ {010}.	Tric. Tab. {010}, elong. *c*.	{010}dist.	Wax-yellow.	H=3.5 G=5.8	Tw. pl.{010}. F=1.5.
1.87	2.01	2.00	Leadhillite $4PbO.SO_3.2CO_2.H_2O$	10° $\rho<\nu$ strong.	X∧*c*=5½° Z=*b*.	Mon. Plates {001}	{001} very perf.	Colorless.	H=2.5 G=6.26 to 6.44.	Effervesces in HNO_3. F=1.5.
2.00	2.02	2.01	Volborthite $6(Cu,Ca,Ba)O.V_2O_5.15H_2O$	0 to 90° $\rho \gtrless \nu$ very strong.	X nearly ⊥ plates.	Six-sided tablets.	One perf.	Olive-green, citron-yellow.	H=3 to 3.5 G=3.55	F=1.5(?). Pleoc.: X=nearly colorless, Y and Z=pale green.
1.908	2.065	2.05	Pinakiolite $3MgO.B_2O_3.MnO.Mn_2O_3$	32° Disp. mod.	X=*b* Z=*a*.	Orth. Rect. tablets{010}.	{010}perf.	Black.	H=6 G=3.88	Sol. in HCl. F=5. Pleoc. not strong in reddish brown.

2.042	2.050	2.050	Pyromorphite $9PbO.3P_2O_5.PbCl_2$	Very small		Ps. hex. Pris.	{10$\bar{1}$0} {10$\bar{1}$1} traces.	Green, yellow, brown, white.	H=4 G=6.5 to 7.1	Sol. in HNO_3. F=1.5. Pleoc.: X=greenish-yellow, Z=green. 2V increases with As.
1.804	2.078	2.076	Cerusite $PbO.CO_2$	8° $\rho > v$ large.	X=*c*. Z=*a*.	Orth. Pris. *c*.	{110}{021}dist.	Colorless.	H=3 G=6.5	Sol. in dil. HNO_3. F=1.5.
1.95	2.10	2.09±	Emmonsite Hydrated ferric tellurite.	20°± $\rho > v$ strong.	Y=*b*. X nearly ⊥ to a cleav.	Mon. Fibers, plates.	{010}perf. Other less so.	Clear yellow-green.	H=5.	In section colorless.
B=0.01		2.09±	Montanite $Bi_2O_3.TeO_3.2H_2O$	Small $\rho < v$ extr.	Tend to lie nearly ⊥ X.	Fib		Yellowish-white earthy incrustations.	Soft G=3.79	Sol. in dilute HCl. F=1.5. Very abnormal green interference colors.
1.70	2.23±	2.10	Metahewettite $CaO.3V_2O_5.9H_2O$	52°	X ⊥ blades. Z // elong.	Orth.(?) Broad blades.		Red	G=2.51	Slightly sol. in H_2O. Fus. easily. Pleoc.: X=light orange-yellow, Y and Z=deep red.
1.816	2.126(?)	2.102	Fiedlerite $PbO.2PbCl_2.H_2O$		Z=*b*. X∧⊥{100}=6°.	Mon. Tab.{100}.	{001}dist	Colorless.	H=3 G=5.88	Sol. in HNO_3.
2.077	2.158	2.116	Laurionite $PbCl_2.PbO.H_2O$	82°	X=*a*. Z=*c*.	Mon. Ps. orth. Pris. *b* or tab.{100}.	{100}dist	do	H=3 G=6.05	Sol. in HNO_3. F=1. Tw. pl. {001}.
2.118	2.135	2.13	Mimetite $9PbO.3As_2O_5.PbCl_2$	29° or less	X=c.	Ps. hex. Pyr. *c*.	{10$\bar{1}$1}imperf.	Yellow to brown.	H=3.5 G=7.1	Isomor. with pyromorphite, vanadinite, etc. Sol. in HNO_3. F=1. Basal sect. in six segments with ax. pl. // edges of hexagon.
2.04	2.15	2.15	Matlockite $PbO.PbCl_2$	0±	X=c.	Ps. tetrag.	{001}perf.	Yellow, etc.	H=3 G=7.21	Decpd. by HNO_3. Fus. easily.
B=0.05±		2.16±	Bismutite $Bi_2O_3.CO_2.nH_2O$(?)	Medium	Z=elong.	Massive Fibers.		Colorless, etc.	H=4 G=7.0±	Sol. in HNO_3. F=1.5. May be in part amorphous.
2.16	2.18	2.18	Kleinite Hg,NH_4, and Cl.	Small $\rho < v$ very strong.		Ps. hex. Short prisms.	{0001}good.	Yellow to orange.	H=3.5 G=7.98	Sol. in HCl. Volatile. Darkens on exposure but regains its original color in dark. Uniax. above 130°. Poly. tw.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
1.77	2.35	2.18	Hewettite $CaO.3V_2O_5.9H_2O$		Z=elong.	Orth. Slender blades.			G=2.55	Slightly sol. in H_2O. Fus. readily to a red liquid. Pleoc.: X and Y=very light orange-yellow, Z=dark red.
2.00_{Li}	2.35_{Li}	2.18_{Li}	Tellurite TeO_2	90° $\rho>\upsilon$ mod.	X=*b*. Z=*c*.	Orth. Tab.{010}, acic. *c*.	{010}very perf.	White	H=2 G=5.90	Fus. Flexible.
2.13	2.20	2.19	Baddeleyite ZrO_2	30° $\rho>\upsilon$ rather strong.	$X \wedge c=12°$ Y=*b*.	Mon. Tab.{100}.	{001}perf.	Colorless to black.	H=6.5 G=5.7±	Decpd. by conc. H_2SO_4. Nearly infus. Poly. tw. {100}and{110}.
1.94	2.51	2.20	Lepidocrocite $Fe_2O_3.H_2O$	83° Disp. slight.	X=*b*. Y=*a*.	Orth. Blades {010} elong. *c*.	{010}very perf. {001}perf. {100}good.	Red, streak dull orange.	H=4 G=4.1	Pleoc. strong: X=clear yellow, Y=red-orange, Z=orange-red. Abs.: X<Y<Z.
2.11	2.22	2.22	Vauquelinite $5(Pb,Cu)O.2CrO_3.P_2O_5$	Near 0	$X \wedge$ fibers small.	Mon. Fib.		Green to brown black.	H=3 G=6.0±	Sol. in H_2SO_4. F=2(?). Pleoc.: X=pale green, Z=pale brown. Abs.: Z>X. Tw. pl. {102}.
2.15	2.23	2.22	Goethite (impure) $Fe_2O_3.H_2O+nH_2O$	Small Disp. strong.	Orth. Tetrag.	{010}perf.		Yellow, streak same.	H=5 G=3.8±	Sol. in HCl. Infus. Pleoc.: X=clear yellow, Y=brownish yellow, Z=orange yellow.
2.09	2.26	2.24	Tungstite $WO_3.H_2O$	Med. small $\rho<\upsilon$ rather strong.		Orth.	One perf.	Yellow to green. Earthy.	H=2.5 G=5.52(?)	Sol. in KOH but not in acids. Infus. Abs. rather strong: X>Y>Z.
2.17	2.32	2.26	Cuprodescloizite $2PbO.2CuO.V_2O_5.H_2O$	73°± $\rho>\upsilon$ very strong.	X=fibers	Orth. Stalactites, fib.	None	Siskin to olive green, brown.	H=3 to 4 G=6.1	Sol. in dilute HNO_3. F=1.5. Pleoc. marked: X=very pale yellow, Y and Z=deep reddish brown.
B=0.05±		2.26	Bismutite $Bi_2O_3.CO_2.nH_2O(?)$			Fib.		Colorless, etc.	H=4 to 4.5 G=6.9±	Sol. in acid. F=1.5. May be in part amorphous.

....	....	High....	Pyrobelonite........ $4(Mn,Pb)O.V_2O_5.H_2O$	....	X=*a*........ Y=*b*.	Orth........ Pris.	None........	Deep red.....	H=3.5 G=5.38	Near descloizite. Mn:Pb=7:4.
2.18	2.35	2.27	Descloizite........ $4(Pb,Zn)O.V_2O_5.H_2O$	Large........ $\rho<v$ rather strong.	X=*c*........ Z=*a*.	Orth........ Short prisms.	None........	Red, brown, black.	H=3.5 G=6.0±	Sol. in dilute HNO_3. F=1.5.
2.17	2.31	2.29	Goethite (impure)..... $Fe_2O_3.H_2O+nH_2O$	42°........ $\rho>v$ very strong.	X=*b*........ Z=*c*.	Orth........ Fib. *c*.	{010}perf.....	Yellow, streak same.	H=5 G=3.8±	Sol. in HCl. Infus. Pleoc. X=clear yellow, Y=brownish yellow, Z=orange-yellow.
2.21_{Li}	2.33_{Li}	2.31_{Li}	Cuprodescloizite....... $2PbO.2CuO.V_2O_5.H_2O$	47°±........ $\rho>v$ strong.	X=fib........	Orth........ Stalactites, fib., grains.	None........	Siskin to olive green, brown.	H=3 to 4 G=6.1	Sol. in dilute HNO_3. F=1.5. Pleoc. faint to strong in canary-yellow, etc.
2.21_{Li}	2.35_{Li}	2.35_{Li}	Goethite........ $Fe_2O_3.H_2O$	Near 0........ $\rho<v$ extr.	X=*b*........ $Y_{Na}=c$. $Y_{Li}=a$.	Orth........ Fib. *c*.	{010}very perf.	Brown to black.	H=5 to 5.5 G=4.2±	Sol. in HCl. Infus. Pleoc.: perceptible: X=brown, Y=brown-yellow, Z=clear orange-yellow. Abs.: X<Y and Z.
2.21_{Li} 2.26_{Na}	2.35_{Li} 2.40_{Na}	2.35_{Li} 2.39_{Na}	Goethite (pure)....... $Fe_2O_3.H_2O$	Small........ $\rho>v$ extr.	X=*b*........ Z=*c*.	Orth........ Fib. *c*.	.....do........	.....do........	H=5 to 5.5 G=4.0 to 4.4	Sol. in HCl. Infus. Pleoc. perceptible in red-brown. Abs.: X<Y and Z.
2.25_{Li}	2.36_{Li}	2.35_{Li}	Schwartzembergite.... $2PbO.Pb(I,Cl)_2$	Small........ Disp. slight.	....	Ps. tetrag.....	None........	Honey-yellow.	H=2 to 2.5 G=6.2	Sol. in hot HNO_3. F=1.
2.18	2.35	2.35	Valentinite........ Sb_2O_3	Very small.... $\rho<v$ marked.	X=*a*........ $Z_{Li}=b$.	Orth........ Fib. *c*.	{010}perf.....	White, gray, rose, etc.	H=3 G=5.57	Sol. in HCl. F=1.5. Volatile.
B=very low.	....	2.38	Perofskite........ $CaO.TiO_2$	90°±........ $\rho>v$.	....	Ps.-isomet.....	Cubic dist.....	Brown-black..	H=5.5 G=4.04	Decpd. by H_2SO_4. Infus. Complex poly. tw. Isot. in part.
B=extreme.	....	2.40_{Li}	Ferrocolumbite....... $FeO.Cb_2O_5$	....	....	Orth........	Poor........	Black........	H=6...... G=6.26±	Insol. Infus. Nearly opaque Abs. rather strong: Z>X.
2.41_{Li}	2.51_{Li}	2.50_{Li}	Pucherite........ $Bi_2O_3.V_2O_5$	20°±........ $\rho<v$ extr.	X=*c*........ Y=*a*.	Orth........ Tab.{001}, acic.	{001}perf.....	Reddish brown	H=4 G=6.25	Sol. in HCl with evolution of Cl. F=2.
2.45_{Li}±	2.55_{Li}±	2.55_{Li}±	Turgite........ $2Fe_2O_3.H_2O$±	Near 0........	Elong.–......	Compact, fib..	....	Brownish black. Powder red.	H=5 to 6 G=4.3±	Solid solution of goethite and hematite. Difficultly sol. in acid. Infus. Pleoc. faint.
B=very strong.	....	2.55_{Li}	Koechlinite........ $Bi_2O_3.MoO_3$	Very large....	Y=*c*........ Z=*a*.	Orth. Sq. tablets{100}. Diagonal striations // *c*.	{100}perf.....	Greenish yellow.	....	Sol. in HCl. Fus. Pleoc. in thick sections. May be opt.+.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Biaxial negative group—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
2.48_{Li}	2.60_{Li}	2.58_{Li}	Smithite (?) $Ag_2S.As_2S_3$	26° ± $\rho > \upsilon$ strong.	$Y = b$ $Z \wedge c = 6°$.	Mon. Hex. tablets.	{100}perf.	Scarlet to vermilion, streak same.	H=2 G=4.88	Pleoc. very weak. See Trechmannite (p. 144).
2.46_{Li}	2.61_{Li}	2.59_{Li}	Realgar AsS	$40°_{Li}$ ± $\rho > \upsilon$ very strong.	$Y = b$ $X \wedge c = 11°$. Disp. strong.	Mon. Short prisms *c*.	{010} rather perf. Sectile.	Aurora-red to orange-yellow.	H=1.5 to 2 G=3.56	Sol. in alkalies. F=1. Volatile. Pleoc.: X=nearly colorless, Y and Z=pale golden yellow.
2.35_{Li}	2.66_{Li}	2.64_{Li}	Terlinguaite Hg_2OCl	$20°_{Li}$ $\rho < \upsilon$ extr.		Mon. Pris. *c*.	{101}perf.	Sulphur-yellow, etc.	H=2 to 3 G=8.73	Volatile.
B=extreme.		3.	Xanthoconite $3Ag_2S.As_2S_5$	2E=125° ± $\rho < \upsilon$.	Y near *a*. $Z = b$.	Mon. Ps. trig. Tab. {001}	{001}dist.	Orange-yellow, etc.	H=2 to 3 G=4.1 to 5.6	Sol. in HNO_3. F=1. In section lemon-yellow. Tw. pl. {001}common.
B=extreme.		3.	Livingstonite $HgS.2Sb_2S_3$			Pris.	Pris. at 90°.	Lead-gray, streak red.	H=2 G=4.81	F=1. Volatile. Faintly pleoc. in red.
B=very strong.		3.	Polybasite $9(Ag,Cu)_2S.Sb_2S_3$	2E=70° ±	$X = c$ $Y = a$.	Mon. or orth. Tab. {001}	{001}imperf.	Iron-black, in splinters cherry-red.	H=2 to 3 G=6.1	Decpd. by HNO_3. F=1 with spurting. In section cherry-red.
3.078_{Na} 2.779_{Li}	3.188_{Na} 3.073_{Li}	3.176_{Na} 3.063_{Li}	Hutchinsonite $(Tl,Ag,Cu)_2S.PbS.2As_2S_3$(?)	38° $\rho < \upsilon$ extr.	$X = b$ $Z = c$.	Orth. Flattened rhombs.	{100}good.	Scarlet to vermilion, streak same.	H=1.5 to 2 G=4.6	Pleoc. very weak. Abs. strong.
B=very strong.		3.27(?)	Smithite $Ag_2S.As_2S_3$	65° ±	$Y = b$ $Z \wedge c = 6°$.	Mon. Hex. tablets.	{101} perf.	do	H=1.5 to 2 G=4.88	Pleoc. very weak.
3.194	4.303	4.046	Stibnite Sb_2S_3	26° Disp. extr.	$X = c$ $Z = b$.	Orth. Acic. Striated *c*.	{010} highly perf. {100}{110} imperf.	Lead-gray, streak same.	H=2 G=4.6	Sol. in HCl. F=1. Translucent to red. Luster metallic.

Minerals of unknown optical character.

[The few minerals in this group were so finely crystalline, so intricately twinned, so weakly birefracting, or so deeply colored that their optical character has not been determined. A number of these very finely crystalline minerals may not be homogeneous or may be submicroscopic impure varieties of some mineral that apparently has rather different composition and other properties. A difference in content of water, in particular, is a very unsafe criterion for distinguishing between the very finely crystalline minerals, for the content of water in many of them varies according to the treatment of the material before analysis, and a specimen analyzed shortly after being taken from the ground may contain much more water than it would contain after it had been kept in a dry place for some time. This water may be in part hygroscopic water and in part may come from admixed amorphous material.]

B = weak		1.427	Ralstonite $(Na_2,Mg)F_2.$ $3Al(F,OH)_3.2H_2O$			Isomet. Oct.		Colorless	H=4.5 G=2.61	Insol. in HCl. Infus. Opt. anom. Divides into sections corresponding to oct. Alteration of cryolite.
			Mallardite $MnO.SO_3.7H_2O$			Mon. Fib.		do		Rapidly loses water on exposure.
1.472	1.474	1.473	Flokite $(Ca,Na_2)O.Al_2O_3.$ $9SiO_2.6H_2O$	Large	Z=b. X∧c=5°.	Mon. Pris.	{100}{010}perf.	do	H=5 G=2.10	Insol. in acid. Fus. easy with intumescence. Tw. pl. Cross sections divided into segments with different optical orientation. Opt.+ at 117° C.
B = 0.02		1.48	Vashegyite $4Al_2O_3.3P_2O_5.30H_2O$		Elong.+	Minute fib.		White, yellowish, greenish.	H=2 to 3 G=1.96	Easily sol. in acid. Infus.
B = feeble		1.500	Bilinite $FeO.Fe_2O_3.4SO_3.$ $24H_2O$	Ext. 35° to 39°.		Fib.		White to yellow.	H=2 G=1.875	An iron halotrichite.
		1.51	Hisingerite Hydrous silicate of $FeO,Fe_2O_3,MgO.$			Cryptocrystalline.		Black, brownish-black.	H=3 G=2.5 to 3.0	Decpd. by HCl. Infus. In part amorphous.
B = strong		1.52±	Zebedassite $5MgO.Al_2O_3.6SiO_2.$ $4H_2O$		Ext. // Elong.+	Fib.		White	H=2 G=2.19	Gelat. Infus.
			Ilesite $(Mn, Zn, Fe)O.SO_3.$ $4H_2O$			Mon.(?) Pris.		Clear green		Sol. in H_2O. Loses water on exposure.
B = 0.01		1.537	Chalcedony SiO_2			Fib.			H=6 G=2.6	Insol. Infus.
B = 0.02±		1.55	Zepharovichite $Al_2O_3.P_2O_5.6H_2O$			Cryptocrystalline fib., plates.		Grayish, greenish, yellowish.	H=5.3 G=2.37	Sol. in HCl. Infus.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Minerals of unknown optical character—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
		1.57	Lacroixite $2Na(F, OH).2(Mn,Ca)O.Al_2O_3.P_2O_5.H_2O$			Mon.(?)			H=4.5 G=3.13	
		1.57±	Bauxite $Al_2O_3.2H_2O$			Colloidal, concretionary.		White	G=2.55	Insol. in acid. Infus.
B=0.01		1.575	Loewigite $K_2O.3Al_2O_3.4SO_3.9H_2O$			Cryptocrystalline.		Earthy	H=3 to 4 G=2.67	Sol. in hot acid. Infus.
B=0.02±		1.583	Bakerite $8CaO.5B_2O_3.6SiO_2.6H_2O$					White	H=4.5 G=2.7 to 2.9	Gelat. with HCl. Fus. to a white transparent bead.
1.593	1.607	1.603	Crestmorite $4CaO.4SiO_2.7H_2O$		Z=elong.	Fib.		do.	H=3 G=2.22	Decpd. by acid. Fus. easy.
1.595	1.603	1.60	Riversidite $2CaO.2SiO_2.3H_2O$		do.	do.		do.	H=3 G=2.64	Decpd. by acid. F=2.
1.585	1.635		Chrysocolla(?) $CuO.SiO_2.nH_2O(?)$		Elong.+	Fib. Opal-like.		Green	H=2± G=2.4±	Decpd. by acid. Infus. Pleoc. Indices may appear much lower until pores are filled with immersion media.
1.62	1.63		Ectropite $12MnO.8SiO_2.7H_2O$		Y=*b*	Mon. (?) Tab.{100}. Elong. *b*.	{001}(?)good	Brown	H=4 G=2.46	Decpd. by HCl with separation of SiO_2. In section yellow and nonpleoc. Related to bementite.
B=0.007		1.635	Podolite $10CaO.3P_2O_5.CO_2$			Hex.			G=3.08	Opt. anom. Sector distribution on base. Hourglass structure in section. ‖*c*. Compare with dahllite (p. 196).
1.645	1.656	1.65	Koninckite $Fe_2O_3.P_2O_5.6H_2O$		Elong. −	Fib., crusts	Transverse	Yellow, green.	H=3 G=2.3 to 2.5	Sol. in strong acid. F=2.5 to 3.

			Kremersite $KCl.NH_4Cl.FeCl_3.H_2O$			Orth Oct.		Ruby red		Sol. in H_2O. Unstable.
B=mod.		1.70±(?)	Johannite(?) Hydrous sulphate of U and Cu.			Mon		Emerald to apple green.	H=2 to 2.5 G=3.19	Sol. in HCl. Infus.
B=weak.		1.725	Sarcopside $6RO.2P_2O_5.RF_2$. R=Fe>Mn>Ca.		Ext. on best Cleav. 45°	Fib	⊥ fib. distinct, // fib. less so.	Flesh-red, lavender.	H=4 G=3.64	Sol. in acid.
B=0.01		1.73±	Stibiconite(?) $Sb_2O_4.nH_2O$		Z=elong.	Fib		White, earthy	H=4 to 5.5 G=5.1 to 5.3	Insol. in HCl. Infus.
1.72	1.80	1.75±	Rutherfordine $UO_3.CO_2$.			Minute fib		Yellow, earthy	Soft G=4.82	Sol. in acid.
1.76	1.81	1.8±	Glockerite $2Fe_2O_3.SO_3.6H_2O$(?)			Fib., crusts		Brown, yellow, black, dull green.	Soft	
B=weak		1.83 to 1.87	Romeite $5CaO.3Sb_2O_5$			Ps. isomet. Oct.		Brown	H=6 G=5.0	Insol. in HCl. Fus. Opt. anom. Divides into sections which show poly. tw. lamellae parallel to the edges. β decreases as Na_2O increases.
B=rather strong.		1.88	Chenevixite $2CuO.Fe_2O_3.As_2O_5.2H_2O$			Cryptocrystalline.		Dark green to greenish yellow.	H=4 G=3.9	F=2.5.
B=0.01±		1.91	Daubréeite $2Bi_2O_3.BiCl_3.3H_2O$(?)			do		Gray powder	H=2 G=6.4	Sol. in HCl. F=1.5(?).
			Molysite $FeCl_3$	0		Hex		Red, yellow, brown.	G=2.80	Unstable.
			Dolerophanite $2CuO.SO_3$			Mon		Brown		Unstable.
			Hydrocyanite $CuO.SO_3$			Orth		Pale blue-green.		Effloresces in contact with air.
B=strong		2.0±	Bindheimite(?) Antimonate of Pb+H_2O					Gray	H=4 G=4.5 to 5	F=3 to 4.

TABLE 7.—*Data for the determination of the nonopaque minerals*—Continued.

Minerals of unknown optical character—Continued.

α	γ	β	Mineral name and composition.	2V Dispersion.	Optical orientation.	System and habit.	Cleavage.	Color.	Hardness and specific gravity.	Remarks.
B=strong		2.05	Fernandinite $CaO.V_2O_4.5V_2O_5.14H_2O$			Fib		Dull green		Partly sol. in H_2O. Sol. in acid to a green solution.
B=weak		2.09	Schneebergite $2CaO.Sb_2O_4$			Ps. isomet. Oct.		Brown, yellow	H=6.5 G=4.1	Insol. Infus.
2.08	2.16	2.1	Trigonite $6PbO.2MnO.3As_2O_5.H_2O$		Y=*b* Ext. 45°.	Mon. Domatic.	{010} very perf. {101} less so.	Sulphur-yellow to brownish.	H=2 to 3 G=8.28	Sol. in acid.
B=strong		2.15	Cuprotungstite $CuO.WO_3.2H_2O$			Cryptocrystalline. Fib.		Green	H=4.5	
(?)		(?)	Rhagite $5Bi_2O_3.2As_2O_3.9H_2O$(?)			Cryptocrystalline aggregates.		Yellow, green	H=5 G=6.82	
B=mod.		2.25±	Bismutite $Bi_2O_3.CO_2.H_2O$(?)			Cryptocrystalline.		Gray, etc. Dull	H=4 to 4.5 G=6.8 to 7.7	Sol. in acid. F=1.5.
(?)	(?)	(?)	Ochrolite $4PbO.Sb_2O_3.2PbCl_2$			Orth. Thick tab. {001}.		Sulphur-yellow.		
B=strong		2.40_{Li}	Ferberite $FeO.WO_3$			Tetrag		Black	H=4 G=6.64	Translucent only in thinnest edges with reddish colors. Pleoc.
B=weak		2.42_{Li}	Minium Pb_3O_4		X / fibers	Cryptocrystalline. Fib., powder		Vivid red, streak orange-yellow.	H=2 to 3 G=4.6	F=1.5. Abnormal green interference color. Pleoc.: Nearly colorless to deep reddish brown.
B=strong		$2.45\pm_{Li}$	Columbite $(Fe,Mn)O.(Cb,Ta)_2O_5$			Orth	{100} good	Black	H=6 G=5.48±	Insol. in acid. Infus. G indicates about 10 per cent Ta_2O_5. Nearly opaque and dark red on thin edges.

B=weak.		2.49$_{Li}$	Eglestonite Hg_4Cl_2O			Ps. isomet.	None	Brownish-yellow. Darkens on exposure.	H=2 to 3 G=8.33	Decpd. by acid. Volatile.
(?)		(?)	Phoenicochroite $3PbO.2CrO_3$				One perf.	Cochineal to hyacinth red.	H=3 to 3.5 G=5.75	Sol. in HCl. F=easy.
B=mod.		2.62±$_{Li}$	Arizonite $Fe_2O_3.3TiO_2$			Mon.(?)	Conch.	Straw-gray.	H=5 to 6 G=4.25	Decpd. by hot H_2SO_4. Translucent only in very thin edges in blood red. Pleoc. weak. Abs.: X<Z.
B=strong		2.63$_{red}$ 3.18$_{blue}$	Tenorite CuO		X oblique to ⊥ plates. On laths ext. X′∧ elong. and tw. pl. =35°.	Tric. Ps. mon. Laths.	$\{111\}\{1\bar{1}1\}$ Unequal perf. {001} less so.	Black scales.	H=3 to 4 G=6.45±	Data on artificial mineral. F = 3. Tw. {100}{011}. Abs. very strong: X<Z, nearly opaque.
B=very strong.		Extr.	Dufrenoysite $2PbO.As_2O_3$			Mon.	{010} perf.	Blackish lead-gray, streak reddish brown.	H=3 G=5.55 to 5.57	Sol. in HNO_3. F=1. Nearly opaque in section and slightly pleoc.
B=very strong.		Extr.	Ilmenite $FeO.TiO_2$			Trig.	None.	Iron-black.	H=5 to 6 G=4.7±	Infus. Nearly opaque.
		Extr.	Sartorite $PbS.As_2S_3$			Orth. Needles.	{001}.	Dull brown.	H=3 G=5.4	Sol. in HNO_3. F=1.
(?)		Extr.	Frieseite $Ag_2Fe_5S_8$			Orth. Tab. {001}.	{001} perf.	Pinchbeck-brown to black.	H=2.5 G=4.21	Opaque to translucent in greenish gray.
(?)		Extr.	Vrbaite $TlAs_2SbS_5$			Orth.	{010} easy.	Brownish-gray to reddish.	H=3.5 G=5.30	Sol. in HCl. Fus. easy.

INDEX.

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