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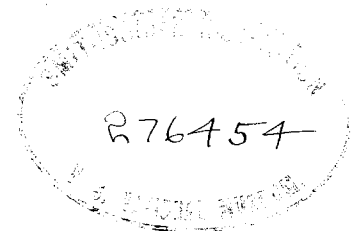
W. H. COLLINS, Director

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CONTRIBUTIONS TO CANADIAN MINERALOGY
AND PETROGRAPHY



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A NEW CANADIAN OCCURRENCE OF PHOSPHORITE FROM NEAR FRANÇOIS LAKE, BRITISH COLUMBIA

The first two lots of the original phosphorite specimens were sent to the Geological Survey simultaneously by J. D. Galloway, now Provincial Mineralogist, Victoria, B.C., and by Mrs. O. Collier, François Lake, B.C. Later on, Mr. G. Hanson collected a large specimen which is represented on Plate I. Recently the writer has received, for museum purposes, half a ton of selected material from Mr. E. M. Dotson, François Lake.

The outcrop from which these specimens were derived is on the farm of Mrs. Collier and about 1,000 feet from her house. The farm is 2 miles northwesterly from the ferry-landing on the north side of François lake. The ferry-landing is 14 miles by motor road from the town of Burns Lake on the Canadian National railway. The discovery is credited to Mr. E. N. Dotson, a brother of Mrs. Collier.

The phosphorite occurs as a small, irregular vein 4 to 12 inches wide, which outcrops at intervals for a distance of about 100 feet. The vein is almost horizontal and probably does not extend far either in length or width. The vein material, which is partly black and partly brown, consists of botryoidal phosphate associated with some asphalt and brecciated andesite.

The geological information regarding Lake François district can be summed up very briefly. G. M. Dawson¹ made a geological reconnaissance of François lake and the area to the south in 1876, and J. D. Galloway,² who collected the vein matter for the present study, made a brief examination in 1923 and again in 1924,³ in company with G. Hanson.

The following account of the mineral occurrence is from the cited report by Hanson.

In the vicinity of Burns and François lakes, the predominant rocks are fragmental and massive volcanic rocks of the Hazelton group (Jurassic). . . . Unconformably on this older basement rest isolated patches of Tertiary sediments and lava flows. The Tertiary rocks were noted especially in the vicinity of François Lake post office, where basaltic lava flows, 100 feet thick, apparently overlie conformably soft, sedimentary rocks. Fossiliferous sediments are present along the northern shore of François lake. The Tertiary rocks do not appear to occupy extensive areas, and the formation is probably only rarely over 200 feet thick. Fossils . . . from these rocks on the northern shore of François lake . . . have been examined by W. A. Bell . . . (who concludes that the formation is) of Upper Eocene age. (The country rock of the vein holding phosphorite, etc.) is basaltic lava, 100 feet thick, and apparently overlies Tertiary sediments . . . The . . . vein lies between basalt walls and has a gentle dip parallel to the dip of the lava flows. . . . The wall-rock is rather friable, and the vein has the appearance of a filling between two flows of lava rather than the filling of a fracture. The possibility is also suggested that the material which gave rise to the phosphate minerals and bitumen accumulated on the surface of one lava flow and was covered by a later lava flow. The phosphate minerals and bitumen may have resulted from guano by a process of distillation in situ occasioned by the heat of the lava.

Galloway states⁴ that the occurrence is vein-like . . . and may represent a cooling fracture in the volcanic rock. It is apparent that the fracture was first partly filled with the brown mineral (phosphate); later the asphaltum in a liquid or semi-liquid condition penetrated along the fissure and in places the brown mineral is soaked and

¹Dawson, G. M.: Geol. Surv., Canada, Rept. of Prog. 1876-77, pp. 17-94 (1878).

²Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1923, pp. 116-118 (1924); 1924, pp. 101-104 (1925).

³Hanson, George: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 42-43 (1925).

⁴Ann. Rept., Minister of Mines, B.C., 1923, p. 117 (1924).

permeated with the asphaltum. . . . Throughout the country rock for distances up to 1,000 feet away from the 'asphaltum vein,' small specks of asphaltum were noted. It is quite apparent that this mineral (asphaltum) came in after the rock was formed . . . (and) that the phosphate mineral was deposited . . . after the volcanic rock cooled, as it is undoubtedly a mineral formed from precipitation from a . . . solution.

The phosphorite nodules are not uniform in size. Their diameter varies from 2 to 8 inches. They consist of a botryoidal mass of phosphates in concentric layers, with an outer coating of black asphalt, and, in most cases, enclosing an angular fragment of andesite (*See Plate I and Figure 1*). It is evident that the andesite had cooled and had been fractured before the phosphates crystallized. In nearly all specimens where the asphalt has been removed, well-terminated quartz crystals, a few millimetres in length, may be observed encrusted on the outer surface of the phosphate. Of the vein material the asphalt was formed last.

Asphalt

The asphalt is the most abundant mineral of the deposit. It was submitted to the late Mr. H. Kohl, chemist of the Fuels and Fuel Testing Division of the Mines Branch, and the results of his investigations are given below.

The sample submitted consisted of a single lump of black, bituminous matter with considerable adhering mineral matter. A careful separation of this foreign matter from the bituminous material was made to obtain:

Sample No. 2478A; 51 grammes with ash content of 0.7 per cent
" 2478B; 39 " " 22.9

Analysis of Sample No. 2478A

Colour.....	Black
Fracture.....	Conchoidal
Lustre.....	Vitreous
Streak.....	Brown
Specific gravity.....	1.06
Melting point (Ball and ring test).....	86° C. (187° F.)
Ash content.....	0.7 per cent
Fixed carbon.....	21.5 per cent
Solubility in petroleum ether.....	56-57 per cent
" carbon tetrachloride.....	99-100 per cent
" carbon disulphide.....	99-100 per cent

According to the above analysis the bituminous material of this sample is an asphaltic pyrobitumen. According to Abraham¹ it falls with the narrow sub-class of wurtzilite asphalt as well as in the broader class of native asphalt (containing less than 10 per cent mineral matter). The origin of these asphaltic pyrobitumens is given as derived from the metamorphosis of petroleum.

Phosphorites

A few years ago Professor A. Lacroix described the phosphorites of France and its colonies². These descriptions were presented so clearly that Dr. W. T. Schaller³ published a brief résumé of Lacroix's results for

¹Abraham, Herbert: "Asphalts and Allied Products," p. 480.

²Lacroix, A.: Sur la constitution mineralogique des phosphorites francaises; Compt. Rend., vol. 150, 1910, p. 1213; Mineralogie de la France, vol. 4, second part, 1910, p. 555.

³Schaller, W. T.: U.S. Geol. Surv., Bull. 509, Mineralogical Notes, ser. 2, pp. 89-100.

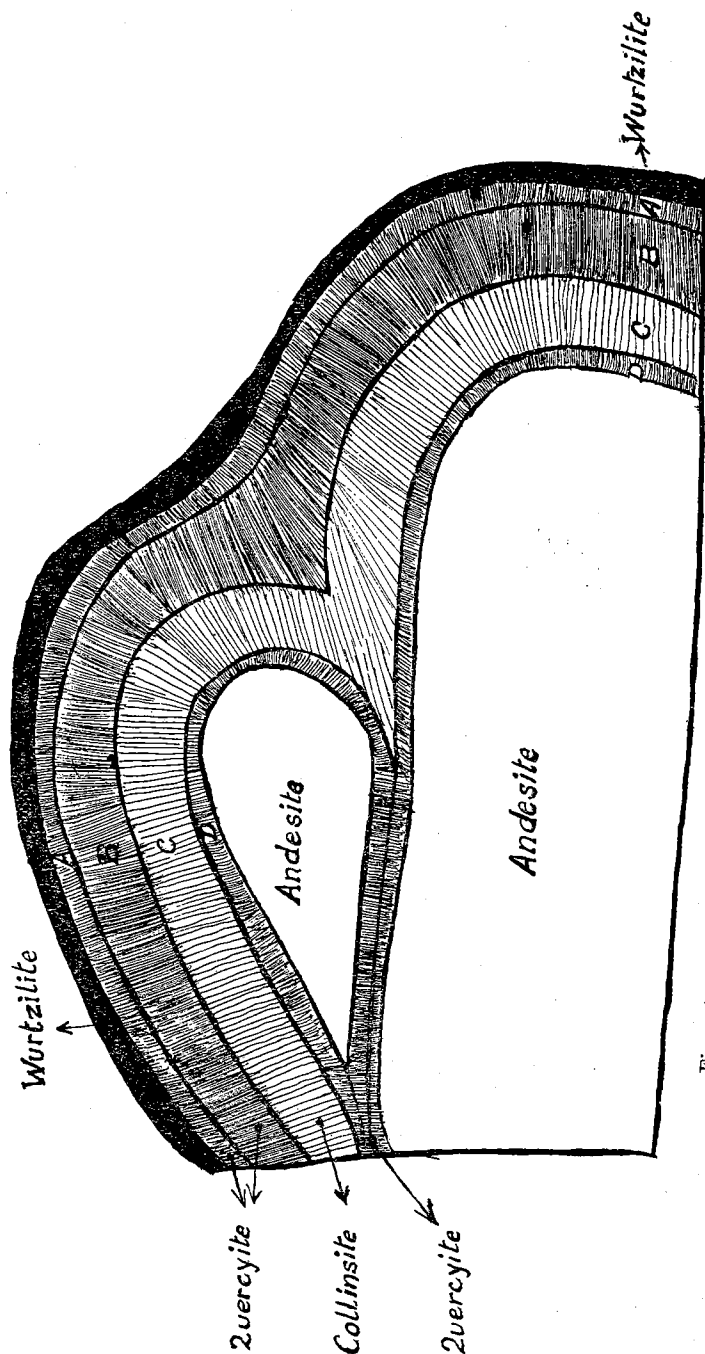


Figure 1. Structure of the phosphate nodules, François lake, B.C. (Natural size.)

the information of American mineralogists. The following extracts from Schaller's paper will facilitate the description of the Canadian phosphorite.

The French phosphorites are of three types: (1) holocrystalline, fibrous; (2) amorphous (isotropic), homogeneous; (3) mixture of the amorphous and holocrystalline.

(1) The holocrystalline, fibrous type is composed of either dahllite or francolite. Dahllite is a hydrous carbonate and phosphate of lime (free from fluorine), francolite and staffelite are considered by Lacroix to be identical, but the name staffelite is kept for the fibrous variety of francolite. Damour's hydroapatite also is francolite. Francolite is similar to dahllite in composition, but contains notable amounts of fluorine.

(2) The amorphous, perfectly isotropic type is composed of the mineral collophanite, which is a hydrous carbonate and phosphate of lime, generally free from any appreciable amount of fluorine, but rarely containing a small amount (fluocollophanite).

(3) The third type is composed of the following minerals, in varying amounts:

(a) Dahllite; (b) francolite (var. staffelite); (c) an unknown mineral, similar to dahllite and francolite in chemical composition, but differing optically from them; (d) collophanite.

This type of phosphorite, composed of an amorphous mineral and one or more crystalline minerals, is called quercyite. If the unknown mineral ((c) above) is absent, the subtype is called α -quercyite; if the unknown mineral is present, the subtype is called β -quercyite. Quercyite is in many cases formed of alternating layers of α -quercyite and of β -quercyite.

The Lake François phosphorite is unlike anything that has yet been described. It is essentially an association of quercyite and collinsite, a new mineral which was named after W. H. Collins, Director of the Geological Survey, Canada. A characteristic specimen containing both minerals is illustrated in Figure 1. The three layers A, B, and D are quercyite. They are of variable width and where narrowest have a somewhat wavy structure in addition to their general botryoidal curvature. They are characterized by their dark brown colour and by having a cryptocrystalline appearance. The layer C represents collinsite. This mineral is very prominent and can be easily distinguished from quercyite by its lighter colour and coarser crystallization.

COLLINSITE, A NEW MINERAL

The collinsite layers consist of a medium brown mass of elongated blades having their axis approximately perpendicular to the surfaces of the layers. The blades vary in size from 1 centimetre in length by $\frac{1}{2}$ millimetre in width, to those of microscopic dimensions, and are not grouped with any particular optical orientation. The blades of collinsite are light brown and somewhat translucent, with a silky lustre. The specific gravity is 2.95 and the hardness is 3.5. Before the blowpipe the mineral fuses, with intumescence, at 3 into a brownish slag. It is easily soluble in acid and gives a strong reaction for water in the closed tube. Since quercyite decrepitates and does not fuse before a blowpipe, collinsite may be easily distinguished from it by a simple fusibility test.

Optical Properties

The collinsite blades lack crystallographic forms and in order to determine the relationships between the optical and the crystallographic elements, the writer employed the Fedoroff method as revised by Nikitin, using the universal stage on a microscope specially designed for the purpose.

By oil immersion on crushed fragments the indices of refraction were found to be as follows:

$$\alpha = 1.632 \pm 0.003; \beta = 1.642 \pm 0.003; \gamma = 1.657 \pm 0.003.$$

The birefringence is positive and as calculated from the above figure is:

$$(\gamma - \alpha) = 0.025; (\beta - \alpha) = 0.010; (\gamma - \beta) = 0.015.$$

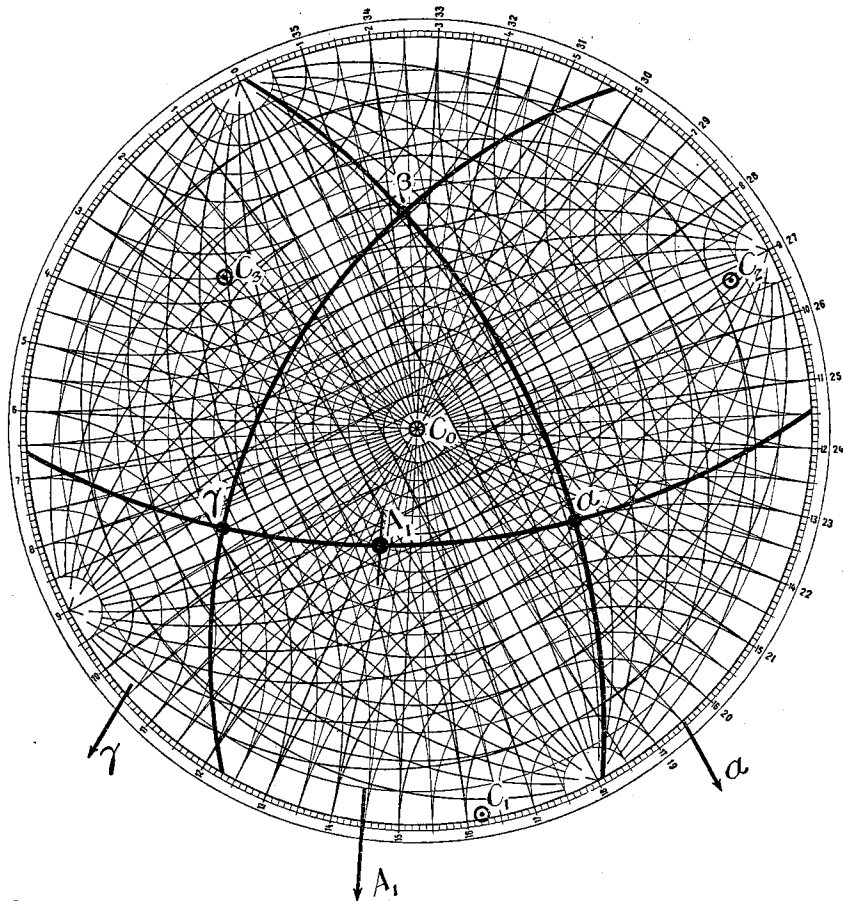


Figure 2. Collinsite from lake François, B.C. Optical and crystallographic elements plotted on the stereographic plat of Fedoroff. (C_0 , C_1 , C_2 , and C_3 are cleavages.)

The elongation was also determined to be positive.

The results of an extensive study using the Universal stage are presented in Figure 2, constructed with a Fedoroff stereographic plat as a basis.

Examination of the figure (C_0 is the best cleavage) shows that γ being the acute bisectrix, the mineral is positive; it shows also that $2V = 80^\circ$ and that four cleavages, numbered C_0 , C_1 , C_2 , C_3 in order of perfection, have

no symmetrical relationship with the axial plane and hence that the mineral can be safely assigned to the triclinic system. Using a special compass designed by Fedoroff the cleavage angles were determined to be as follows:

$$\begin{aligned} C_0 \wedge C_1 &= 88^\circ 40' \\ C_1 \wedge C_2 &= 108^\circ 00' \text{ or } 72^\circ \\ C_2 \wedge C_3 &= 111^\circ 00' \text{ or } 69^\circ \\ C_1 \wedge C_3 &= 131^\circ 00' \text{ or } 49^\circ \end{aligned}$$

Likewise the angles between the normal to the axial plane and the normals to cleavages were found to be:

$$\beta \wedge C_1 = 150^\circ; \beta \wedge C_2 = 66^\circ; \beta \wedge C_3 = 44^\circ.$$

These last figures fully locate the position of the axial plane with respect to the cleavages. Again, from the plat it may be seen that, owing to their large polar distances, the γ and β axes could not, respectively, be brought into parallel position with the microscope tube by tilting the stage. It was possible, however, to do so in the case of the α axis and, therefore, to calculate the birefringence ($\gamma - \beta$). The actual amount of retardation R_1 of one of the rays transmitted by the crystal plate behind the other was measured with a babinet compensator, whereas the thickness of the mineral section was determined by Nikitin's method using a micrometer ocular. The value ($\gamma - \beta$) = 0.015, thus obtained, is exactly what was determined by calculation from the indices of refraction.

As shown in the chemical discussion farther on, collinsite belongs to the Roselite group. This being so, and because of the correspondence of the measured angles in the two minerals as tabulated below, it follows that the cleavages in collinsite correspond in all probability to the faces indicated in the same table.

Roselite	Collinsite
Mm = $48^\circ 47'$	C_1C_3 49°
CM = $89^\circ 20'$	C_0C_1 $88^\circ 40'$
bm = $66^\circ 09'$	C_2C_3 $69^\circ 00'$
bM = $65^\circ 03'$	C_2C_1 $72^\circ 00'$
C (001)	C_0
b (010)	C_2
m (110)	C_3
M ($\bar{1}\bar{1}0$)	C_1

Chemical Properties

Material suitable for analysis was carefully prepared by the writer, and through the courtesy of the Chemical Division of the Mines Branch the analytical work was carried on in duplicate by Mr. E. A. Thompson, with the following results:

	1	Molecular ratio		2
P ₂ O ₅	39.83	0.280	0.280 = 1 x 0.280	37.72
CaO.....	32.18	0.575	0.575 = 2 x 0.287	31.11
FeO.....	6.86	0.095		15.63
Fe ₂ O ₃	0.80	0.005		
Mn ₂ O ₃	0.36	0.005		
MnO.....				
Al ₂ O ₃	0.39	0.004	0.268 = 1 x 0.268	trace
MgO.....	6.34	0.159		
F.....	0.27	0.014		1.45
CO ₂	0.23	0.006		
H ₂ O -105.....	0.15	0.690	0.710 = 2½ x 0.284	
+105.....	12.28			
C.....	0.18			12.15
SiO ₂	0.10			
Less O	99.97			Insol. 1.40
Equivalent to F.....	0.11			99.46
	99.86			

(Cr, Na, K, Sn, Ba, Ti, Cl, and WO₃ were absent.)

Analysis 1. Collinsite from lake François, B.C., by E. A. Thompson.
 Analysis 2. Composition of messelite is given for comparison. E. S. Dana, "System of Mineralogy," p. 812.

The formula for collinsite derived from the above ratios may be written P₂O₅ Ca₂ (Mg Fe) 2½ H₂O in which the magnesium oxide is decidedly in excess of the ferrous oxide. Thus, collinsite is a new mineral representing the magnesium end member of an isomorphous series of which messelite represents the iron end. The formula for messelite is given by Dana¹ as P₂O₅ (CaFe)₃ 2½ H₂O. Since the calcium oxide content seems to be constant for collinsite and messelite, Dr. Wherry² suggests that in the formula the calcium should not be included with the iron and magnesium in a parenthesis to show isomorphism, but that the parenthesis contains only Mg and Fe. The C and SiO₂ are no doubt derived respectively from wurtzilite and andesite impurities and the F and CO₂ may be due to some admixed quercyite.

Collinsite and messelite may be briefly compared as follows:

	Collinsite	Messelite
Crystallography.....	Triclinic.....	Triclinic
Optically.....	+	+
2V.....	80°	Medium
α.....	1.632	1.640
β.....	1.642	1.653
γ.....	1.657	1.680
Birefringence.....	0.025	0.040
Gravity.....	2.95	3.00
Hardness.....	3-3.5	3-3.5
Composition.....	P ₂ O ₅ Ca ₂ (Mg Fe) 2½H ₂ O	P ₂ O ₅ Ca ₂ (Fe Mg) 2½H ₂ O
Ratio of MgO to FeO.....	62.6 : 37.4	14.2 : 85.8

¹Dana, E. S.: "A System of Mineralogy," p. 812.
²Private communication.

If the refractive indices for collinsite and messelite are plotted with respect to their magnesium and iron oxides content it is feasible by extrapolation to obtain approximate values of the indices for the possible pure end members of the series, that is, the pure magnesium and the pure iron compounds (See Figure 3). The pure magnesium compound will be optically negative and have approximately the following indices:

$$\alpha = 1.623; \beta = 1.633; \gamma = 1.640.$$

The pure iron compound will be optically positive and have:

$$\alpha = 1.648; \beta = 1.657; \gamma = 1.687.$$

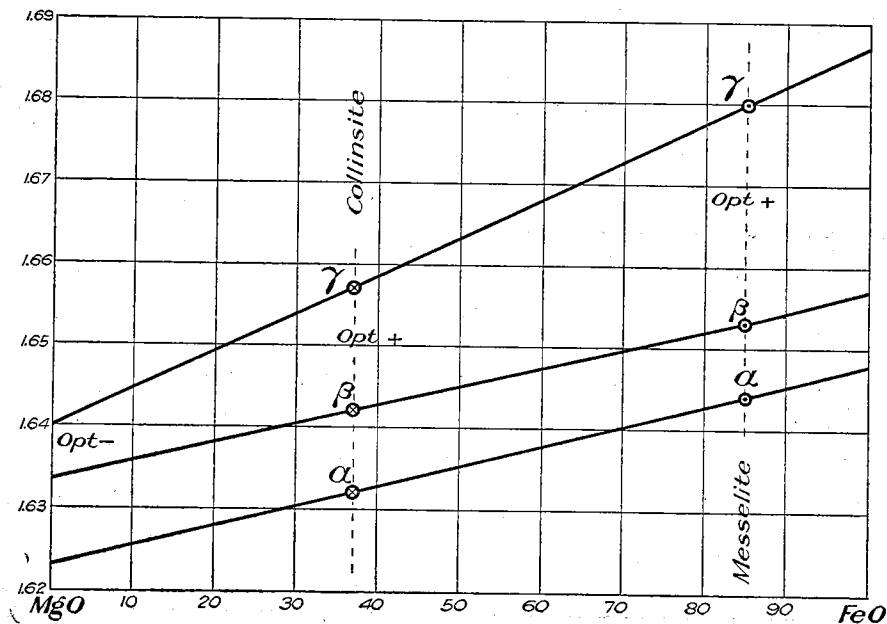


Figure 3. Refractive indices of the collinsite-messelite series.

QUERCYITE

As already stated the British Columbia phosphorite is composed of collinsite, wurtzilite, and quercyite. The name quercyite is given to a substance which was found to have the same chemical composition as the original material described by Lacroix under that name.

Another factor which would seem to strengthen the view that the British Columbia mineral is typical quercyite is that a microphotograph of a thin section made from it (Plate II) is practically identical with a microphotograph of French quercyite given by Alfred Lacroix in the "Mineralogy of France."¹ On the other hand the original quercyite is described as an admixture of dahllite or francolite, with variable proportions of isotropic collophanite. Microscopic examination reveals that the Canadian quercyite is practically composed of one mineral, probably closely related to the fibrous form of francolite. The mean refractive

¹Lacroix, Alfred: Tome Quatrieme, 2c Partie, fig. 1, p. 580.

index for quercyite is given by Lacroix as 1.608. The figures obtained for the British Columbia mineral are quite different, and are as follows:
 $\alpha=1.613 \pm 0.002$; $\beta=1.626 \pm 0.002$; $\gamma=1.629 \pm 0.002$.

Thus the birefringence is slightly higher than that of dahllite or francolite. The Canadian quercyite is distinctly biaxial with $2V=5^\circ$ to 10° . The specific gravity of French quercyite varies from 2.83 to 2.87, whereas the density of Canadian quercyite is 3.04, a figure closer to the gravity of pure francolite than to the original quercyite. The British Columbia quercyite has a hardness of 4.5. It does not fuse under the blowpipe, but decrepitates violently, emitting a perceptible amount of volatile matter.

Material carefully prepared by the writer was analysed in duplicate by E. A. Thompson of the Mines Branch. The average of these two analyses is given below in column 1; the other three analyses are quoted from Lacroix's "Mineralogy of France."

Analysis of Quercyite

	1	2	3	4
P ₂ O ₅	34.96	37.60	36.60	37.75
CaO.....	50.22	51.85	50.45	52.50
FeO.....	1.90			
Fe ₂ O ₃	0.12	Fe ₂ O ₃ } Al ₂ O ₃ }	1.30	0.85 _a
Mn ₂ O ₃	0.12			
Al ₂ O ₃	0.60			
MgO.....	0.62			
F.....	1.83	1.50	0.83	
CO ₂	5.45	4.00	4.62	5.70
H ₂ O + 105.....	4.20	4.80	6.00	3.20
SiO ₂	0.19			
C.....	0.82			
Less O equiv. to F.....	101.03 0.77			
	100.26	99.75	99.80	100.00

No. 1 (Cr, Na, K, Sn, Ba, Ti, SO₃, Cl, and WO₃ were absent.)

Analysis 2. From Mouillac, Tarn-et-Garonne, France.

Analysis 3. From Mouillac, Tarn-et-Garonne, France.

Analysis 4. From Belmez, Cordova, Spain.

a—Contains a little F.

From analyses 1 to 4 given above, the following molecular ratios are obtained:

Molecular Ratios, Quercyite Analyses

	1	2	3	4	Average
CaO.....	0.896	0.926	0.900	0.937	
P ₂ O ₅	0.246	0.264	0.257	0.265	
F.....	0.096	0.080	0.043		
CO ₂	0.124	0.090	0.105	0.130	
H ₂ O.....	0.233	0.270	0.333	0.180	
CaO.....	100	100	100	100	100
P ₂ O ₅	27	28	28	27	27½
F.....	10	9	5		8
CO ₂	13	10	10	13	11½
H ₂ O.....	26	28	37	19	27½

The quercyite from British Columbia is certainly not pure francolite nor dahllite as the following ratios show:

Molecular ratio	(Quercyite)	(Dahllite)	(Francolite)
	1	2	3
CaO.....	100	100	100
P ₂ O ₅	27	29	29
F.....	10	18
CO ₂	13	12	7
H ₂ O.....	26	10	9

Analysis 1. Quercyite, B.C.

Analyses 2 and 3. Schaller, W. T.: U.S. Geol. Surv., Bull. 509, Mineralogical Notes, ser. 2, pp. 98 and 99 (1912).

It appears to be typical quercyite which carries an appreciable amount of colophonite, but this contradicts the results furnished by microscopical examination, as these show the British Columbia quercyite to be composed of one definite mineral having characteristic indices of refraction, birefringence, and specific gravity. The simple formula $3\text{CaO P}_2\text{O}_5 \text{CaO CO}_2 \text{H}_2\text{O } \frac{1}{2}\text{CaF}_2$ derived from chemical analysis strongly suggests that quercyite may not only be one mineral but a new one. Further research on foreign quercyite should prove very interesting.

ORIGIN OF PHOSPHORITE

The phosphate deposit at François Lake has not been examined in detail, consequently it is not definitely known how the phosphates formed. The deposit in some respects is similar to a deposit of quercyite referred to by Professor Lacroix¹, which is found at Bozouls in the department of Aveyron, France, and which unlike other French quercyite deposits does not occur in limestone but in basaltic tuffs. The quercyite occurs as concretions here and there in the eruptive rocks. Professor Lacroix does not attempt to describe the origin of this particular deposit. It might be of interest, however, to give his views on the origin of the deposits which occur in the limestone.

Following a long period of marine invasion in the beginning of Tertiary time, caverns and fissures were made in the limestone. These were later on (in Eocene and Oligocene time) filled with debris from running water in a fashion somewhat similar to the one seen today in action in caverns. Clays which were residual products of limestone were concentrated in these caverns. The remains of animals who once lived in these caverns or were carried there by running water yielded phosphate to solutions which attacked the limestone walls, and also added themselves to the lime phosphate already contained in the residual clays. Running water carrying carbonic acid remanipulated these phosphates and determined their crystallization as concretions in clay or on the walls of the caverns. The importance of the role played by carbonic acid is strongly put in evidence by the fact that it is an essential element of all the phosphate deposits. At Herault, where numerous interesting deposits of phosphate occur, a blue Oxfordien limestone is found containing large amounts of bats' bones, and the brain is sometimes entirely transformed into phosphate.

Mr. G. Hanson believes that the phosphorite of lake François is a filling between two flows of lava rather than the filling of a fracture. He also suggests that the material of the vein accumulated on the surface

¹Loc. cit.
37233-2

of one lava flow, and was covered by a later lava flow. According to him, the phosphate minerals and bitumen have probably resulted from guano or other organic material by a process of distillation in situ occasioned by the heat of the lava. Without consulting Mr. Hanson, the writer had arrived at the same conclusion, and would say further that careful prospecting in similar geological horizons will probably be rewarded by the discovery of deposits which might have more favourable commercial chemical composition (that is to say—freedom from iron, magnesium, and alumina).

Other Identified Minerals Associated with the Phosphates and the Brecciated Andesite

VIVIANITE

Vivianite occurs sparingly in several specimens as a thin crust on wavy veinlets of quercyite. It probably has been derived from quercyite through the action of iron-bearing solutions.

PYRITE

Small cubes of iron pyrites were recognized in several specimens of andesite.

OLIVINE

Olivine is an important constituent of a basalt collected in the vicinity of the phosphate occurrence.

CALCITE

Natrolite, heulandite, and chalcedony were observed filling geodes which are abundant in the andesite associated with the phosphate-bearing vein.

QUARTZ

Some quartz crystal aggregates of common habit, a few millimetres long, coat the quercyite-collinsite nodules. They appear to be older than the asphalt.

OPTICAL PROPERTIES OF CHEMICALLY ANALYSED FERROPREHNITE FROM ADAMS SOUND, BAFFIN ISLAND

Although prehnite is a common mineral and often has been described and analysed, very little data regarding its refractive indices have so far been published. Johannsen, Larsen, Winchell, Iddings, Dana, and others, in their text books give the same indices and apparently derived them from the work of Levy and Lacroix on prehnite from Ratschinges, Tyrol. These indices are as follows:

$$\alpha = 1.616, \beta = 1.626, \gamma = 1.649.$$

They are of a prehnite having the following composition:

Prehnite from Ratschinges, Tyrol

	Per cent
SiO ₂	43.40
Al ₂ O ₃	24.53
Fe ₂ O ₃	27.37
CaO.....	4.48
H ₂ O.....
Total.....	99.78

Dana's Textbook¹ contains fourteen analyses of prehnite differing considerably from one another, but only a slight variation of the axial angle and of the birefringence has been observed on prehnite from various localities, although the varying chemical composition strongly suggests that their refractive indices should appreciably differ. A few years ago, R. A. A. Johnston² described a prehnite from Adams sound containing 6.89 per cent of ferric oxide, to which variety the name ferroprehnite was given. This prehnite is somewhat similar in composition to a prehnite from Cornwall, Pennsylvania, analysed by Genth. The present writer undertook the determination of the optical properties of the ferroprehnite from Adams sound in order to compare them with those of the Ratschinges prehnite which is free from iron.

The ferroprehnite examined under the microscope came from the same specimen that furnished the material analysed by Johnston. The principal constituents of the specimen, which has a granitic structure, are quartz, calcite, and ferroprehnite, all intimately associated. The colour of the ferroprehnite is light apple green, but in thin section it is colourless. Thus in physical appearance it does not differ from common prehnite.

The axial plane is either parallel to b(010) or to a(100); the mineral is biaxial and positive; and the cleavage angle $m \wedge m = 80^\circ$. The indices of refraction carefully measured were found to be as follows:

$$\alpha = 1.632 \pm 0.001; \beta = 1.642 \pm 0.001; \gamma = 1.665 \pm 0.001.$$

2V measured = $68^\circ 10'$, and calculated from the above figures is = $67^\circ 38'$. Thus the Ratschinges prehnite which represents one pole of a series may be compared as follows with the ferroprehnite of Adams sound representing the other pole.

	Ratschinges, Tyrol	Adams sound, Baffin island
SiO ₂	43.40	41.85
Al ₂ O ₃	24.53	20.36
Fe ₂ O ₃	6.89
CaO.....	27.37	26.70
H ₂ O.....	4.48	4.19
Total.....	99.78	100.00
Specific gravity.....	2.90	2.924 at 15.5°C.
α	1.616	1.632
β	1.626	1.642
γ	1.649	1.665
2V calculated.....	$67^\circ 40'$	$67^\circ 38'$

¹Dana, E. S.: "A System of Mineralogy," p. 531.

²Johnston, R. A. A.: Geol. Surv., Canada, Bull. No. 1, pp. 95-98 (1913).