2. Contributions to Swedish Mineralogy

by

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Part II.

9. On the Chemical Composition of Chondrodite, Humite, and Clinohumite from Nordmark, and on the Constitution of the Minerals of the Humite Group in general.

In the articles 3, 4, and 5 in my Contributions to Swedish Mineralogy[1] I have given a detailed account of the crystallographic development and the optical characters of the humite minerals from Nordmark. I will now give an account of the investigation of their chemical composition, owing to the complicated nature of which this investigation has required more time than I had expected.

Previous investigations. The chemical composition of the minerals of the humite group is a subject of the greatest interest on account of the crystallographic relations between these minerals. Notwithstanding the pretty large number of analyses, the question as to their true chemical composition has been unsettled until lately. There has been great difference of opinion especially with regard to the important question whether the three minerals are identical with each other in composition, or the crystallographic differences are connected with differences in the chemical constitution.

Leaving the earlier analyses by d'OHSSON, LANGSTAFF, SEYBERT, W. FISCHER a. o. out of consideration, it is chiefly RAMMELSBERG, VOM RATH, HJ. SJÖGREN, WINGARD, and, of late, PENFIELD and HOWE[2] that have treated the question of the chemical composition of these minerals. Single analyses have, besides, been made by BREIDENBOUGH, HAWES, WIDMAN, CHYDENIUS, and BERWERTH.

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[1] Bulletin of the Geol. Inst. Vol. I, p. 16—40.

[2] The interesting article by PENFIELD and HOWE, which forms a most valuable contribution to our knowledge of the chemical composition of these minerals, did not come into my hands, till the analyses given below were completed.

As long as the three minerals were regarded only as different forms of the same mineral species, which view was held by Scacchi, their chemical identity seemed, of course, most probable. And during that period the three types of humite were, indeed, universally considered as chemically identical; whether the composition of chondrodite was the same as that of humite, was a matter of dispute.

To RAMMELSBERG we are indebted for the first accurate investigations of chondrodite and humite. He first analyzed chondrodite from American and Finlandian localities[1], later also humite of all three types from Vesuvius, for which analyses the material was supplied by SCACCHI[2].

From his analyses he derived the common formula $8MgO \, . \, 3SiO_2$, in which part of the oxygen was considered to be replaced by fluorine. RAMMELSBERG also believed he had found a difference in the percentage of fluorine between the three types, and to this he ascribed the difference in crystalline form. On account of the high percentage of fluorine of some chondrodites he regarded that mineral as a fourth type of humite.

This view was, however, at variance with the fact, soon after proved by KOKSHAROW's[3] investigation, that the crystalline form of the Finlandian chondrodite agreed exactly with that of the humite of type II, though they differed in percentage of fluorine.

Later, VOM RATH has published new analyses made on Vesuvian humite of all three types as well as on chondrodite from Kafveltorp[4]. He showed that the varying percentage of fluorine is not the cause of the variation of type, but that the types are essentially similar in composition, and he proposes the formula $5MgO \, . \, 2SiO_2$.

In the second edition of his »Handbuch der Mineralchemie»[5] RAMMELSBERG has abandoned his earlier view of the relation of the percentage of fluorine to the different crystalline forms of the types, and by comparing his own analyses with those made by others he reaches the conclusion that the analyses admit of three formulæ, $Mg_{13}Si_5O_{23}$, $Mg_8Si_3O_{14}$, and $Mg_5Si_2O_9$, to the last of which he, finally, gives the preference on account of its simplicity. By assuming that part of the oxygen is replaced by fluorine RAMMELSBERG in reality gets two isomorphous compounds in humite, and, therefore, writes the formula $n\,Mg_5Si_2O_9 + Mg_5Si_2F_{18}$, where the value of n varies from 9 to 43.

In 1882, when publishing my crystallographic investigations of the chondrodite from Kafveltorp and the humite from the Ladu mine, I also gave an account of some new analyses of these minerals[6]. These analyses caused me to enter on a discussion of the composition of the minerals of

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[1] Pogg. Ann. Vol. 53, p. 130.

[2] Pogg. Ann. Vol. 86, p. 404.

[3] Mater. zur Mineralogie Russlands, Vol. 6, p. 71.

[4] Pogg. Ann. Vol. 147, p. 258.

[5] L. c. p. 434 and 705.

[6] Lunds Univers. Årsskrift Vol. 17, and Zeitschr. für Kryst. Vol. 7, p. 344.

the chondrodite group in general. I called attention to the fact that most analyses of chondrodite and humite show a considerable loss, and explained it as due to hydroxyl entering into the composition. Further, as the analyses that show the greatest losses, give the smallest amounts of fluorine and *vice versâ,* I inferred from this that the fluorine replaces a hydroxyl group, instead of assuming with RAMMELSBERG and VOM RATH that it replaces the oxygen[1]. Moreover, by comparing with one another analyses of each of the three minerals I showed that a distinct difference in composition is observable between them, and proposed the following formulæ:

Clinohumite . . . $Mg_5 [Mg (F . OH)]_2 [Si O_4]_3$
Humite . . . . . . $Mg_3 [Mg (F . OH)]_2 [Si O_4]_2$
Chondrodite . . . $Mg_4 [Mg (F . OH)]_4 [Si O_4]_3$

I also called attention to the probability, suggested by these formulæ, of the minerals forming a morphotropic series.

As will be shown in the following pages, later analyses and investigations have confirmed in the main the view advanced by me in 1882. That water is present as hydroxyl in all the minerals of the humite group, and that part of it is isomorphously replaced by fluorine, has been universally admitted. It will also be shown in the present paper that the three minerals differ from each other in composition, and that they form a morphotropic series, although their formulæ are not the same as those suggested by me in 1882. The analyses made up to that time were too imperfect, especially as regards the determinations of $Si O_2$ and water, to admit of the deduction of the correct formulæ, though the view then advanced by me was correct in principle[2].

A short time after, WINGARD[3] was induced by Prof. GROTH of Munich to undertake a new investigation of the composition of the humite minerals, and published a number of analyses made on humite minerals from Vesuvius as well as on chondrodite from Kafveltorp and the Ladu

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[1] Already GROTH (Tabell. Uebers. 1882, p. 88) suggested, that hydroxyl partly replaces fluorine, and RAMMELSBERG (Mineralchemie 1875 p. 436) thought it possible that the losses in most analyses may depend on the presence of water.

[2] I quote here the closing words of my article of 1882 in Zeitschr. für Kryst. Vol. 7, p. 361. "In vorliegendem Aufsatze hat Verfasser die Auffassung der chemischen Zusammensetzung der zur Chondroditgruppe gehörenden Mineralien veranschaulicht, zu welcher eine Discussion der vorhandenen Analysen ihn geführt hat. Dass die Frage dadurch definitiv abgemacht sei, hat er nicht zu behaupten gewagt. Nach den Analysen, die gegenwärtig zu Gebote stehen, scheinen jedoch die hier dargestellten Ansichten die natürlichsten zu sein oder doch wenigstens absoluten Vorzug vor den allgemein angenommenen zu haben, welche laut vorstehender Auseinandersetzung weder den Resultaten der Analysen entsprechen noch vom theoretischen Standpunkte aus wahrscheinlich sind. Dass Verf. auf gewisse Verwandtschaften zwischen den Krystallformen und der chemischen Zusammensetzung der fraglichen Mineralien hat hinweisen können, scheint dafür zu sprechen, dass der eingeschlagene Weg wenigstens in der Hauptsache der richtige gewesen."

[3] Zeitschr. für analyt. Chemie. Vol. 24, p. 314. 1885.

mine. From his analyses WINGARD concludes that the three types of humite are identical in composition, and proposes for them the following formula, which is rather complicated and already on that ground seems improbable:

$$Mg_{13} (Mg\,F)_4 \,.\, (Mg\,.\,OH)_2 \,(Si\,O_4)_8.$$

This formula has been accepted by most authors of Text-books, as NAUMANN, HINTZE, KLOCKMANN, DANA, and has also been adopted by GROTH in his »Tabellarische Uebersicht»[1].

When the analyses given below as well as the experiment I undertook to ascertain the constitution of the minerals, were completed, I received PENFIELD and HOWE's paper »On the Chemical Composition of Chondrodite, Humite and Clinohumite», printed in the March number of this year of the American Journal of Science (Vol. XLVII, p. 188—206). The authors give eight new analyses on material from American localities, Vesuvius, and Kafveltorp, and also discuss the earlier analyses of other authors. By their most interesting work the two authors succeed in setting the difference in composition between the three minerals beyond doubt, and propose for them the following formulæ:

Chondrodite . . . $Mg_3 [Mg (F\,.\,OH)]_2 [Si\,O_4]_2$
Humite . . . . . . $Mg_5 [Mg (F\,.\,OH)]_2 [Si\,O_4]_3$
Clinohumite . . . $Mg_7 [Mg (F\,.\,OH)]_2 [Si\,O_4]_4$.

The authors also show that there exists a most remarkable relation between these formulæ and the crystalline forms of the minerals.

It may be said at once that the analyses published in the present paper agree very closely with those just published by my American colleagues, and give the same formulæ. With great satisfaction I have found my analyses substantiated by those of the American authors, as, on the other hand, their results are confirmed by those arrived at by me.

After my investigation of the crystallographic relations of the humite minerals from Nordmark, which investigation was published a year ago, had proved the occurrence in that locality of the three species, humite, chondrodite, and clinohumite, it became of great interest to subject them to a chemical examination. The chemical examination of the minerals from a new locality offered an opportunity of gaining information on the question as to the identity or non-identity in composition of the minerals, which question, in spite of WINGARD's latest contributions to the subject, I could not regard as definitely settled. And having found in mr R. MAUZELIUS an analyst who for care and accuracy has proved equal to the most

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[1] Groth even finds that the three minerals "*offenbar* drei Modificationen derselben Substanz bilden". L. c. p. 108.

difficult problems, I could now take up the question with greater hopes of coming to a definite solution.

The plan of the work also embraced trials to ascertain the constitution by the methods so successfully introduced by CLARKE.

Material. Methods of analysis. All of the analyses have been made on material that had been subjected to a careful crystallographic examination so as wholly to prevent confusion with any one of the other minerals. Previous to the analyses the material was most carefully prepared: it was first treated with a strong electro-magnet in order to extract any magnetite that might be disseminated through it, and then it was freed from impurities by treatment with heavy liquids, the solutions of THOULET and ROHRBACH. Before the analysis the material was carefully examined under the microscope; the results of these examinations are given in connection with the respective analyses.

Concerning the method of analysis the following statements may suffice:

The percentage amounts given in the column *a* in each analysis (in An. XIV also those under *b*) were obtained by using the Berzelius method of analyzing silicates containing fluorine, consequently by fusing the powdered mineral with sodium and potassium carbonates. In a few analyses fluorine has, besides, been determined according to the method of Fresenius, by being weighed as $Si F_4$; these figures are given in the columns *d* (except in An. XIV, where no such determination was made).

For the determination of alcalies, the presence of which in the minerals of the humite group has been shown for the first time by these analyses, and also for duplicate determinations of the bases, a quantity was dissolved in $H Cl$, whereupon $Si O_2$ and bases were determined in the usual way. The percentages of $Si O_2$ found in this way were in every case too low, which must be due to the escape of $Si F_4$[1]. The values of $Si O_2$ thus obtained are given within parentheses, but have not been taken into account.

The water was determined by ignition with sodium carbonate in a platinum boot, placed in tubes of difficultly fusible Bohemian glass. However, the heat could never be raised sufficiently to completely fuse the sodium carbonate, which after ignition was only more or less strongly sintered. The strongest heat was obtained in the analyses XIV and XV (the second chondrodite analysis and the analysis of clinohumite), in which was used an oven that gave a considerably stronger heat than the one used in the other analyses. The heat was lowest in analysis XII (the

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[1] WINGARD's statement that the humite minerals dissolve in hydrochloric acid with disengagement of HF, was not, consequently, confirmed. The differences between the several determinations of silicic acid prove that part of the silicium had gone off as $Si F_4$, though this part bears no fixed proportion to the amount of fluorine. Possibly the amount of $Si O_2$ which on solution goes off as $Si F_4$ depends on the degree of concentration of the hydrochloric acid used.

second humite analysis) and next in analysis XIII. In interpreting the analyses this must be borne in mind[1].

I. Humite.

Two analyses of humite were made on somewhat different material. For An. XI the material was selected from a specimen with crystals of the size of a cm. and the development shown by fig. 11 Pl. II. The material was dark brown and, when examined with the microscope, was found to be perfectly clear, pure and undecomposed.

For the determinations *a* were used 0.7630 gr. dried at + 115° C.
» » » *b* » » 0.5192 » » » »
» » » *c* » » 0.5455 » » » »
» » » *d* » » 1.0152 » » » »

All of the determinations are, consequently, made on a fully sufficient quantity of material of excellent quality.

Analysis XI. (R. Mauzelius).
Humite, brownish yellow, from Nordmark.
Gravity 3.32 at 15° C.

	a	b	c	d	Mean values	Molecular ratio
SiO_2	35.44	[33.71]	—	—	35.44	0.587
TiO_2	0.07	—	—	—	0.07	0.001
Al_2O_3	0.28	0.10	—	—	0.19	0.002
Fe_2O_3	0.79	0.57	—	—	0.68	0.004
FeO	—	—	10.96	—	10.96	0.152
MnO	1.46	1.49	—	—	1.47	0.021
CaO	0.17	—	—	—	0.17	0.003
MgO	—	47.22	—	—	47.22	1.172
K_2O	—	0.17	—	—	0.17	0.002
Na_2O	—	0.29	—	—	0.29	0.005
H_2O	1.28	—	—	—	1.28	0.071
F_2	3.66	—	—	3.92	3.79	0.100
	—	—	—	—	101.73	—
O corresponding to F_2	—	—	—	—	1.60	—
	—	—	—	—	100.13	—

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[1] After the perusal of PENFIELD and HOWE's paper, in which they mention the apparatus they had to make use of in order to completely expel the water from the humite

If, in calculating the formula, the slight amount of TiO_2 is reckoned in with SiO_2, if, further, FeO, MnO, CaO, and the alcalies are calculated as equivalent quantities of MgO, and the small amounts of Al_2O_3 and Fe_2O_3, too, are assumed to replace MgO, making R_2O_3 enter for 3 RO, the following ratio ist obtained:

$$\begin{array}{llll} & SiO_2 & : RO & : F.HO \\ & 0.588 & : 1.373 & : 0.342 \\ \text{or} & 3 & : 7 & : 1.74 \end{array}$$

It is remarkable that the ratio of SiO_2 to RO is exactly 3 : 7, and it cannot be doubted that the formula must contain these two constituents in these proportions. The proportion of (F . OH) is less obvious but approximates to 2.

Analysis XII. (R. Mauzelius).
Humite, yellowish grey, from Nordmark.
Gravity 3.24 at 16° C.

	a	b	c	d	Mean values	Molecular ratio
SiO_2	35.21	[34.69]	—	—	35.21	0.583
TiO_2	0.07	—	—	—	0.07	0.001
Al_2O_3	0.13	0.02	—	—	0.07	0.001
Fe_2O_3	0.99	1.12	—	—	1.06	0.007
FeO	—	—	7.93	—	7.93	0.110
MnO	1.75	1.62	—	—	1.69	0.024
CaO	0.11	—	—	—	0.11	0.002
MgO	—	48.33	—	—	48.33	1.200
K_2O	—	0.20	—	—	0.20	0.002
Na_2O	—	0.34	—	—	0.34	0.005
H_2O	1.85	—	—	—	1.85	0.103
F_2	—	—	—	4.59	4.59	0.121
	—	—	—	—	101.45	—
O corresponding to F_2	—	—	—	—	1.93	—
	—	—	—	—	99.52	—

The second analysis was made on smaller crystals of a lighter appearance. The lighter colour is evidently due to the lower percentage

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minerals, which retain it with the greatest intensity, it is easily explained, why in the analyses given in these pages the determinations of the water percentage deviate in some cases from the theoretical values.

of iron and the lower gravity. The material for this analysis was found to be less perfect than that used in the preceding one, as among the main mass of perfectly clear and fresh grains it contained a few turbid and not quite transparent ones. The small quantity of such grains and the slight degree of alteration which they showed were, however, thought to be too unimportant to influence the result of the analysis. It is possible, however, that the higher percentage of water that this analysis shows, is due to this alteration.

For the determinations *a* were used 0.6100 gr. dried at + 115° C.
» » » *b* » » 0.5108 » » » »
» » » *c* » » 0.4623 » » » »
» » » *d* » » 0.3508 » » » »

Applying to this analysis the same method of calculation as to the preceding one, the following ratio is obtained:

$$\begin{array}{rcccc} & SiO_2 & : RO & : (F . HO) \\ & 0.584 & : 1.367 & : 0.448 \\ \text{or} & 2.99 & : 7 & : 2.29 \end{array}$$

Also in this analysis the ratio of SiO_2 to RO is very near 3 : 7, while (F . OH) approximates to 2.

The agreement between the two analyses is shown by the following comparison:

$$\begin{array}{lccc} & SiO_2 & : RO & : (F . HO) \\ \text{Anal. XI} & 3.00 & : 7 & : 1.74 \\ \text{» XII} & 2.99 & : 7 & : 2.29 \\ \text{Mean of the two An.} & 3.00 & : 7 & : 2.01 \end{array}$$

From this mean the formula for humite is deduced, *viz.*

$$7\,MgO . 3\,SiO_2 . 2\,(F . OH) \text{ or}$$
$$Mg_5\,[Mg\,(F . OH)]_2\,(SiO_4)_3.$$

2. Chondrodite.

Of chondrodite, too, two analyses were made. The first of these was made on greyish yellow crystals that had nearly the appearance shown by figs. 2, 3, and 4, Pl. III in my crystallographic description of chondrodite. Thin sections as well as the powder showed the material to be perfectly fresh and undecomposed.

For the determinations *a* were used 0.6088 gr. dried at 115° C.
» » » *b* » » 0.6170 » » »
» » » *c* » » 0.5507 » » »
» » » *d* » » 0.9456 » » »
» » » *e* » » 0.8543 » » »

Analysis XIII. (R. Mauzelius).

Chondrodite, greyish yellow, from Nordmark.
Gravity 3.24 at 16° C.

	a	b	c	d	e	Mean values	Molecular ratio
SiO_2	34.44	[31.31]	—	—	34.44	34.50	0.571
Al_2O_3	0.16	—	—	—	—	0.16	0.002
Fe_2O_3	0.65	0.61	—	—	—	0.63	0.004
FeO	—	—	6.59	—	—	6.59	0.092
MnO	1.53	1.48	—	—	—	1.50	0.021
CaO	0.26	—	—	—	—	0.26	0.005
MgO	—	51.39	—	—	—	51.39	1.275
K_2O	—	0.16	—	—	—	0.16	0.002
Na_2O	—	0.90	—	—	—	0.90	0.014
H_2O	1.22	—	—	—	1.14	1.18	0.066
Fl_2	4.64	—	—	4.87	—	4.76	0.125
	—	—	—	—	—	102.03	—
O corresponding to Fl_2	—	—	—	—	—	2.00	—
	—	—	—	—	—	100.03	—

This analysis shows the ratio of silicic acid, bases and (F . HO) to be as follows:

SiO_2 : RO : (F . OH)
0.571 : 1.427 : 0.382
or 2 : 5 : 1.34.

It is remarkable that in this analysis the ratio of SiO_2 : RO is exactly = 2 : 5, which ratio is substantiated by the following analysis. As to the figure for (F . OH), it is probably too low, owing to the circumstance that a sufficiently high temperature could not be obtained with the oven that was used in determinating the water. As was mentioned above, the humite minerals retain their water most intensely. The following analysis of chondrodite, in which the water was determined in an oven which gave an essentially greater heat, shows a far higher figure for this constituent.

The second analysis of chondrodite was made on dark brown material containing a larger amount of FeO and having a somewhat higher gravity. This material was derived from larger crystals of the type shown by figs. 6, 7 Pl. III. When examined under the microscope, this material, too, was found to be very fresh and pure.

For the determinations *a* were used 0.7757 gr. dried at 115° C.
» » » *b* » » 0.9461 » » »
» » » *c* » » 0.6310 » » »
» » » *d* » » 0.6721 » » »
» » » *e* » » 0.5573 » » »

Analysis XIV. (R. Mauzelius).

Chondrodite, dark brown, from Nordmark.

Gravity 3.28 at 18.4° C.

	a	b	c	d	e	Mean values	Molecular ratio
SiO_2	34.21	33.90	[30.41]	—	—	34.05	0.564
TiO_2	0.59	0.13	0.68	—	—	0.13	0.002
Fe_2O_3		0.60		—	—	0.54	0.003
FeO	—	—	—	10.40	10.68	10.54	0.148
MnO	1.18	1.26	1.27	—	—	1.24	0.017
MgO	48.18	48.24	48.49	—	—	48.30	1.199
H_2O	2.19	2.41	—	—	—	2.30	0.128
F_2	5.34	5.45	—	—	—	5.40	0.142
	—	—	—	—	—	102.50	—
O corresponding to Fl_2	—	—	—	—	—	2.27	—
	—	—	—	—	—	100.23	—

Alcalies were not searched for, and Al_2O_3 as well as CaO could not be shown to be present.

Grouping the elements as above, the atomic ratio, consequently, is as follows:

SiO_2 : RO : F . OH
0.566 : 1.373 : 0.540
or 2.06 : 5 : 1.97.

Here, too, the ratio of silicic acid and bases is 2 : 5, as in the preceding analysis, and the figure for (F . OH) closely approximates to 2. By comparing the results of the two analyses we thus find full agreement concerning the ratio between SiO_2 and RO; as for the ratio of (HO.F) to the other constituents we may without hesitation prefer the result of analysis XIV, while in the analysis XIII the determination of H_2O evidently is too low. The ratio RO to (F.HO) being taken = 5 : 2 we get the formula

$$5MgO.2SiO_2.2(F.OH) \quad \text{or}$$
$$Mg_3[Mg(F.OH)]_2(SiO_4)_2.$$

3. Clinohumite.

Of clinohumite only one analysis was made. The material for this analysis, when examined with the microscope, was not found quite so fresh as that used in the other analyses. This circumstance makes it probable that the percentage of water given by the analysis is somewhat high.

For the determinations *a* were used 0.8960 gr. dried at 115° C.
» » » *b* » » 0.5761 » » »
» » » *c* » » 0.5566 » » »
» » » *d* » » 0.8490 » » »

Analysis XV. (R. Mauzelius).

Clinohumite, greyish yellow, from Nordmark.

Gravity 3.35 at 17° C.

	a	b	c	d	Mean values	Molecular ratio
SiO_2	35.86	[34.85]	—	—	35.86	0.594
TiO_2	—	0.06	—	—	0.06	0.001
Fe_2O_3	—	0.22	—	—	0.22	0.001
FeO	—	—	14.25	—	14.25	0.198
MnO	—	1.19	—	—	1.19	0.017
CaO	—	trace	—	—	trace	—
MgO	—	44.66	—	—	44.66	1.108
K_2O	—	0.15	—	—	0.15	0.002
Na_2O	—	0.29	—	—	0.29	0.005
H_2O	1.58	—	—	—	1.58	0.088
F_2	4.02	—	—	4.30	4.16	0.109
	—	—	—	—	102.42	—
O corresponding to F_2	—	—	—	—	1.75	—
	—	—	—	—	100.67	—

Calculating as above, this analysis gives the following ratio:

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\begin{array}{lllll}
 & SiO_2 & : RO & : (HO . F) \\
 & 0.595 & : 1.333 & : 0.394 \\
\text{or} & 4.02 & : 9 & : 2.66.
\end{array}
$$

Also in this case the ratio of SiO_2 to the bases is rather simple, namely 4 : 9, while the figure for (HO . F) does not approximate to any whole number. As, however, owing to the somewhat decomposed condition of the material, the water percentage presumably is too high, it seems very likely that also here the figure in question should be 2, as is the case with the other minerals. The formula may then be written

$$Mg_7 [Mg (F . OH)]_2 (Si O_4)_4.$$

Summary. The formulæ derived from the above analyses are, then, the following:

Chondrodite . . . $Mg_3 [Mg (F . OH)]_2 (Si O_4)_2$
Humite . . . . . . $Mg_5 [Mg (F . OH)]_2 (Si O_4)_3$
Clinohumite . . . $Mg_7 [Mg (F . OH)]_2 (Si O_4)_4$.

These formulæ agree perfectly with those lately given by PENFIELD and HOWE. The analyses of the American authors show that the ratio of F to (HO) varies, being in some analyses, for instance in those of chondrodite from Brewster and Monte Somma, 1 : 1, and in the same mineral from Warwick and Kafveltorp, 2 : 1. In this respect the three humite minerals from Nordmark seem to have a more constant composition, the ratio being for all of them 1 : 1, or at least approximating very closely to that ratio.

As the number of substances entering into the composition of the minerals of the humite group from Nordmark is very large, most of them isomorphously replacing Mg O, the difference in composition between the three minerals, as indicated by the formulæ, is more clearly seen, if all the bases are reduced to equivalent amounts of Mg O, and the small quantity of TiO_2 to silicic acid. This has been done below, where the analyses are given together with the values calculated from the above formulæ, (OH) and F having been calculated as present in equal quantities, which evidently agrees best with the nature of the humite minerals from Nordmark.

Chondrodite.

	Anal. XIII	Anal. XIV	Mean value	Calculated
SiO_2	35.98	35.90	35.94	35.29
Mg O	59.91	58.38	59.14	58.82
Fl	4.97	5.69	5.33	5.59
H_2O	1.23	2.43	1.83	2.65
Total	102.09	102.40	102.24	102.35

Humite.

	Anal. XI	Anal. XII	Mean value	Calculated
SiO_2	37.60	37.17	37.39	37.50
MgO	58.70	58.07	58.39	58.34
Fl	4.02	4.85	4.43	3.96
H_2O	1.36	1.95	1.65	1.87
Total	101.68	102.04	101.86	101.67

Clinohumite.

	Anal. XV	Calculated
SiO_2	38.32	38.77
MgO	57.42	58.16
F	4.44	3.07
H_2O	1.69	1.29
Total	101.87	101.29

With a view of further showing that the results of the analyses agree better with the assumption of three different formulæ than with one common formula for the three minerals, these results have, finally, been tabulated as follows:

Chondrodite [1]			Humite [2]			Clinohumite			Calculated		
SiO_2	: RO	: (HO . F)	SiO_2	: RO	: (HO . F)	SiO_2	: RO	: (HO . F)	SiO_2	: RO	: (HO . F)
0.566	: 1.373	: 0.540	0.586	: 1.370	: 0.375	0.595	: 1.333	: 0.394			
2.06	: **5**	: **1.97**	2.14	: 5	: 1.45	2.23	: 5	: 1.48	**2**	: **5**	: **2** (Chondr.)
2.89	: 7	: 2.75	**3.00**	: **7**	: **2.01**	3.13	: 7	: 2.07	**3**	: **7**	: **2** (Humite)
3.71	: 9	: 3.54	3.85	: 9	: 2.59	**4.02**	: **9**	: **2.66**	**4**	: **9**	: **2** (Clinoh.)

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[1] Anal. XIV.

[2] Mean values of Anal. XI and XII.

As is seen from the table, the figures for silicic acid and bases nearly coincide with the calculated values. The agreement is even greater than in the analyses of PENFIELD and HOWE, who first proposed these formulæ. On the other hand, the agreement is less satisfactory with regard to the figure for (OH . F), owing partly to the somewhat decomposed condition of the material used in some of the analyses, which has tended to give too high a figure for this constituent, partly to the insufficient degree of heat in some analyses, which has made this figure too low.

In one respect the analyses here published show a more complicated composition of the humite minerals than previous analyses do, *viz.* by also containing alcalies. The small amounts of K_2O and Na_2O have been found in all of the analyses except An. XIV (the dark chondrodite). These small quantities of alcalies might possibly be accounted for as having come from the glass, but this does not seem very probable, because in the analyses platinum vessels have been used, whenever it was possible. — This is, likewise, the first time that titanic acid has been found in a mineral of the humite group.

Experiment made to ascertain the constitution of the minerals. That the hydroxyl group entering into the composition of the humite minerals is combined with magnesium as indicated by the above formulæ, is a most legitimate assumption, but has not as yet been shown by any one of those that have investigated the composition of the humite minerals. To set the correctness of this assumption beyond doubt, I tried to apply Clarke's method of fractionated analysis of silicates of magnesia, so successfully used by him in establishing the chemical constitution of the minerals of the serpentine, chlorite, mica, and talc groups[1].

For this purpose a quantity of the chondrodite afterwards analyzed under No. XIV was heated in dry HCl, the directions given by Clarke being followed. The temperature was kept constant at 400° C, and was read off on a quicksilver thermometer from Muenche in Berlin. At first a pretty rapid increase in weight was observed; it, however, gradually diminished, and after 24 hours' heating the weight was constant. In the course of the experiment part of the iron was volatilized as chloride of iron and condensed in the glasstube, where it had to be collected afterwards. It is possible that some small amount had distilled out of the tube so as not to admit of being collected[2].

After this treatment it was found that when solving in water the following amounts were gone into solution:

Mg O	3.85 %		3.85 %
Fe O	0.55 %	calculated as Mg O	0.54 %
» (volatilized)	0.40 %		
			4.39 %.

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[1] Bull. of the U. S. Geol. Survey, 78; Am. Journal of Science 1890, p. 303; 1892 p. 378.

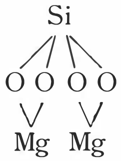
[2] Compare CLARKE in Bull. of U. S. Geol. Survey N:o 78, p. 25.

The amount of Mg required to form the group (Mg . OH), if calculated from the percentage amount of water in this chondrodite, 2,30 $^0/_0$, is found to be 5,15 $^0/_0$, consequently somewhat in excess of the quantity of Mg solved out, 4,39 $^0/_0$. The agreement is, however, as great as could be expected, since also in the trials of Clarke the differences sometimes will be pretty great. Besides, the presumed volatilization of part of the iron accounts to some extent for the difference. At all events this experiment may be said to have set beyond doubt that the group Mg. (OH) enters into the composition of the mineral.

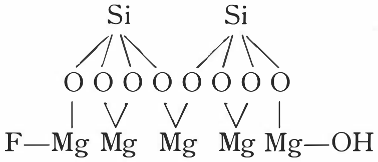
How these humite minerals are derivable from the orthosilicic acid and the normal orthosilicates, is easily seen. The orthosilicate of magnesia constitutes, as is well known, the mineral Olivine, which is also closely related in crystalline form to the humite group, though they cannot be said to be isomorphous. The humite minerals are basic compounds of orthosilicic acid, and all of them contain a greater percentage of metals, relatively to Si, than is the case with the normal orthosilicates, which is due to the fact that the value of saturation of the magnesium is abated by the univalent groups (HO) and F.

If we write the normal orthosilicate in the following way, the relation between this mineral and those of the humite group is easily understood.

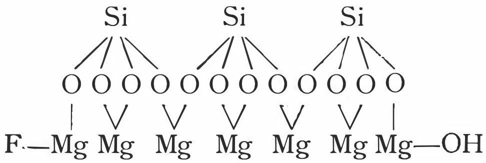
Olivine.



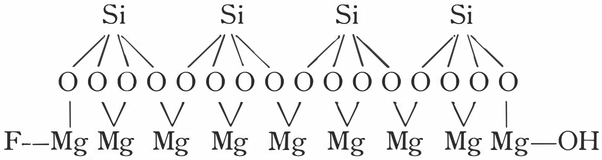
Chondrodite.



Humite.



Clinohumite.



In the article of Penfield and Howe it has already been shown that these formulæ agree very closely with such of the earlier analyses as may claim reliability, except as regards the water percentages, which in all earlier analyses have been either overlooked or determined incorrectly. It is, therefore, unnecessary to show this once more.

As for the relation of the formulæ here proposed to those suggested by me 13 years ago, as well as concerning the singular and most interesting morphotropism which these minerals present in their crystallographic constants, I may also refer to the article of the said authors.

Without presuming too far I hope I may express the opinion that the formulæ now proposed almost at the same time by Penfield and Howe and by me, will be found to represent the true composition of the minerals of the humite group. The analyses of the American authors and those published in this paper have been made simultaneously and independently. They have been made on material carefully determined crystallographically and separated from impurities by means of heavy solutions, and found to be homogeneous. In carrying on the analyses the newest methods have been used, and in the majority of cases the determinations have been controlled by duplicate tests. Moreover, they embrace specimens from most localities of the minerals of the humite group in Europe and America. Lastly, the formulæ proposed have been tested by experiment and found to answer the conception formed of their constitution.

10. Retzian, a new arseniate from the Mossgrufva, Nordmark.

Pl. III. Figs 7—12.

For several years my attention has been turned to a mineral, as yet undescribed, occurring in very small quantities in the manganiferous ore-formation at the Mossgrufva, Nordmark, which includes the well-known hydrous manganesian arsenates, allactite, diadelphite, synadelphite, hemafibrite a. o.

Only by collecting from different quarters all the material that could be had, I have succeeded in obtaining an amount large enough to admit of an examination of the mineral. In the collection of the late mr A. Sjögren, who had also observed this mineral, I found a number of specimens, to which have been added such as I have acquired from mr G. Flink. As, however, the mineral occurs most sparingly, the material acquired has not been sufficient for a complete examination. Therefore, though no small number of specimens have been used up, the chemical composition of the mineral is still unestablished as regards one point. However, not being able, for want of material, to pursue the investigation, I have thought proper not to postpone the description of it, especially as the mineral has been well characterized and defined by the examinations already made.

The mineral occurs in small drusy cavities in a fine-grained mixture of braunite and dolomite. These cavities are, besides, lined with small brilliant octahedrons of jacobsite, which mineral proves to be older than the arseniate in question. Also in the highly decomposed portions of this mineral formation, where the braunite has passed into manganite and pyrochroite, it is always found in drusy cavities. Wherever it be found, the mineral seems to be the youngest, even younger than the yellowish grey, reniform crusts of a crypto-crystalline carbonate with fibrous radiated structure which coat the drusy cavities. The mineral has not been observed to occur associated with, or on the same specimen as, the other closely related minerals, allactite, diadelphite etc.

The minerals always occurs crystallized, and the crystals are 2 to 3 mm. in length, and prismatic or thickly tabular in form. Colour chestnut-brown to chocolate-brown. Streak light brown. Lustre vitreous approaching to greasy; subtranslucent. Hardness about 4. Specific gravity 4,15 at + 14° C. Cleavage not observed. Fracture conchoidal to uneven. Before the blow-pipe the mineral, when heated in a tube, yields water; on charcoal with soda gives off arsenical odours, and reacts for iron and manganese. Easily and completely soluble in hydrochloric acid.

Analysis XVI. (R. Mauzelius).
Retzian from the Mossgrufva, Nordmark.
Gravity 4.15 at 15° C.

	°/o	Molecular Ratio.
As_2O_5	24.4	0.106
PbO	0.2	0.001
FeO	1.7	0.024
MnO	30.2	0.425
CaO	19.2	0.343
MgO	2.7	0.067
SiO_2	0.5	0.008
H_2O	8.4	0.467
insoluble	4.3	
not identified . .	10.3	
	101.9	

For the chief analysis 0.0795 gr. were used. An insoluble residue, amounting to 4.3 p. c., was obtained; of this 1.8 p. c. was found to consist of SiO_2.

Of the analysis the following particulars may be given. The mineral having been dissolved in HCl, As and Pb were precipitated with H_2S, and Fe with sodium acetate. After this, Mn was precipitated with bromine. The manganese precipitate was, after ignition, dissolved in hydrochloric acid, leaving an undissolved greyish white residue, which could not be identified, owing to the small amount (0.0082 gr., corresponding to 10.3 p. c. of the material weighed for the trial).

In order to determine the degree of oxidation of the manganese, a special test for Mn_2O_3 after the method of Bunsen was made. Though only 0.296 gr. could be used in this test, it gave an unmistakable, negative result, showing the manganese to be present only in the protoxide state. No trial was made to ascertain whether As is present as $\overset{V}{As}$ or $\overset{III}{As}$ (as arsenic acid or arsenious acid). The water was weighed directly.

As one of the ingredients could not be identified, the analysis is incomplete, on account of which no formula can be calculated for the mineral at present. At all events, the analysis shows that the mineral is closely related in composition to the already known hydrous arseniates from the Mossgrufva, *viz.* allactite, diadelphite, synadelphite, and hemafibrite, and also to the flinkite from the Harstig mine. Amongst these it comes nearest to those which do not contain trivalent manganese or other sesquioxides, consequently to allactite and hemafibrite. That it cannot, however, as regards its chemical composition, be identified with any one of them, will be clearly seen from the subjoined table.

Table.

	Allactite	Synadelphite	Diadelphite	Hæmafibrite	Flinkite	Retzian
As_2O_5	28.8	28.3	22.6	30.93	30.5	24.4
PbO	—	—	—	—	—	0 2
FeO	—	—	—	—	—	1.7
MnO	62.2	43.5	48.9	57.00	37.6	30.2
Mn_2O_3	—	12.9	—	—	22.3	—
Al_2O_3	—	4.2	7.6	—	—	—
Fe_2O_3	—	—	1.2	—	—	—
SiO_2	—	—	—	—	—	0.5
CaO	—	—	—	—	—	19.2
MgO	—	—	5.5	—	—	2.7
H_2O	9.0	11.1	14.2	12.1	9.6	8.4

The crystals have been found to belong to the orthorhombic system, with the following system of axes

$$a : b : c = 0.4414 : 1 : 0.7270,$$

deduced from the following fundamental angles

$$d\ (101) : c\ (001) = 58^\circ\ 44'$$
$$b\ (010) : m\ (110) = 66^\circ\ 11'.$$

The occurring forms are

$$b = (010) = \infty \check{P} \infty$$
$$c = (001) = oP$$
$$m = (110) = \infty P$$
$$n = (130) = \infty \check{P}3$$
$$d = (101) = \bar{P} \infty.$$

As appears from Figs 7, 9 Pl. III, the crystals are developed prismatically parallel to the *c*-axis and bounded in the prismatic zone by *m* (110) and *b* (010). The prism *n* (130) occurs subordinate. Sometimes they present a tabular development parallel to *b* (010). The basal plane *c* (001) is always present, as is also the macrodome *d* (101). On the whole the crystals are pretty constant in form and development, exhibiting but few variations. Figs 8 and 10 on the same plate represent a regular intergrowth of two crystals in such a position that their prismatic zones coincide, and the two individuals have a symmetrical position with reference to a latent prism (150). As only one such intergrowth has been met with, it has not been possible to ascertain whether this is a case of twinning, which, however, is most probable.

The results of the measurements performed on five crystals are arranged together in the following

Table of angles.

	Measured					Calculated
	1	2	3	4	5	
$b\,(010) : c\,(001)$	89°27′	90°28′	87°43′	88°57′	88°19′	90° 0′
$b\,(0\bar{1}0) : c\,(001)$	88 8	88 17	88 21	87 48	89 55	»
$d\,(101) : c\,(001)$	57 59	60 11	60 37	61 36	55 52	58 44
$d\,(\bar{1}01) : c\,(001)$	59 28	60 49	57 17	58 27	55 2	»
$b\,(010) : m\,(110)$	66 15	67 40	—	67 58	65 12	66 11
$b\,(010) : m\,(\bar{1}10)$	66 49	67 5	65 16	—	—	»
$b\,(0\bar{1}0) : m\,(\bar{1}\bar{1}0)$	66 43	66 25	—	64 53	65 5	»
$b\,(0\bar{1}0) : m\,(1\bar{1}0)$	65 41	—	—	—	65 27	»
$b\,(010) : n\,(130)$	35 47	—	33 45	—	—	—
$b\,(010) : n\,(\bar{1}30)$	—	—	34 49	—	—	—
$b\,(010) : b\,(0\bar{1}0)$	177 35	178 45	176 4	176 45	178 14	180 0′

As is visible from this table, there are very large differences between angles measured on different crystals, which indicates an imperfection in the development of the crystal. This imperfection also appears from the fact that the mean of the angles between the two faces of *b* (010) over the top of the crystals is as mean value for all five crystals 177° 28′, thus deviating 2° 32′ from the theoretical value (180°). The crystals are, consequently, contracted or pointed at the top.

Optical orientation. All plates parallel to the principal pinacoid sections show extinction parallel to the axes, which confirms the orthorhombic character of the mineral. The plane of the optic axes is parallel to *b* (010), and axial images are visible both in the plates parallel to *a* (100) and in those parallel to *c* (010). The optic axial angle is great, and the poles lie beyond the field of view of the microscope. It could not, therefore, be decided, whether the bisectrix of the acute axial angle coincides with the *a*-axis or with the *c*-axis.

By using the $^1/_4$ undulation mica plate the optical orientation was found to be such that the *c*-axis is the direction of the greatest optical elasticity, the *a*-axis that of the least.

Thus $\mathfrak{a}$ coincides with *c*
$\mathfrak{b}$ » » *b*
$\mathfrak{c}$ » » *a*.

The mineral is strongly pleochroic. According as the plates vary in thickness, the following axial colours appear:

$\mathfrak{c}$ strongly brownish red to crimson
$\mathfrak{b}$ dark-brown to reddish brown
$\mathfrak{a}$ wine yellow to orange yellow.

Quantitatively the absorption is

$$\mathfrak{c} > \mathfrak{b} > \mathfrak{a}.$$

The plates present a peculiarity shown by figs 11 and 12. They have a darker nucleus in the form of a four-sided prism, bounded by the three pinacoids; on two of its sides, namely on the macropinacoids, an enlargement has taken place by the formation of additional layers of a lighter substance, which has given rise to new bounds, consisting of the prisms *m* (110), *n* (130), and *d* (101), on these sides.

As already stated, the mineral is closely related in composition to the already known manganese arsenates from the Mossgrufva and the Harstig mine. It does not seem, however, to admit of being united to any one of these.

As it contains bivalent manganese only, its composition is nearest to that of allactite and hemafibrite, but it differs crystallographically from the former mineral, which is monoclinic. With the hemafibrite it agrees in crystallizing in the orthorhombic system, but the two minerals do not seem to be referable to the same fundamental form. Another important difference is that the strongly developed pleochroism which distinguishes the new mineral, is not found in the hemafibrite.

The system of axes of retzian, as given above, comes very near that of the Flinkite from the Harstig mine, as will be seen from the following comparison:

Retzian $a : b : c = 0.4414 : 1 : 0.7270$
Flinkite » » » $= 0.4131 : 1 : 0.7386$.

The accordance is such as to suggest the identity of the two minerals. As, however, according to the analysis of HAMBERG, flinkite contains both protoxide and sesquioxide of manganese, which is not the case with retzian, and as, moreover, the chemical examination shows other not unimportant differences to exist between them, there is at the most only a case of isomorphism. Besides that, the minerals differ widely as regards the optical orientation as well as in their habit and form of development. As the axial systems have been given above, in retzian the plane of the optic axes lies parallel (010), in flinkite parallel (001). Again, the crystals of flinkite are always tabularly developed parallel to basis (001), while the crystals of retzian are prismatic at right angles to that plane.

In my opinion, therefore, the mineral here described cannot be identified with any one of those mentioned above. It differs from all of them in the large percentage of Ca O, amounting to no less than 20 %, while in the other minerals this substance is present only as an occasional, inessential ingredient. The mineral has been named after the swedish naturalist Anders Jahan Retzius (1742—1821).

Characters. Orthorhombic; $a : b : c = 0.4414 : 1 : 0.7270$; no distinct cleavage. Occurs in crystals of prismatic habit. Forms: b (010), c (001), m (110), n (130), d (101). $H = 4$, $G = 4.15$. Lustre vitreous to greasy. Colour dark chocolate-brown to chestnut-brown, streak light brown; subtranslucent. Strongly pleochroic. Is in composition a hydrous arsenate of Mn O and Ca O, containing about 24.4 p. c. of As_2O_5, 30.2 p. c. of Mn O, 19.2 p. c. of Ca O, and 8.4 p. c. of H_2O, besides small amounts of Pb O, Fe O, and Mg O. Before the blowpipe almost infusible; with soda on charcoal gives off arsenical odours. Readily soluble in diluted acids. Found in small drusy cavities in the manganiferous limestone in the Mossgrufva, Nordmark.

11. Pyroaurite from the Mossgrufva, Nordmark. Pl. IV, Figs 1—5.

In 1865 IGELSTRÖM discovered and described[1] a new mineral from Långban, which was found to have the composition $Fe_2O_3 . 6\,MgO . 15\,H_2O$,

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[1] Öfvers. af Kongl. Vet. Akad. Förhandl. 22, 608. 1865.

and for which he proposed the name pyroaurite on account of its assuming a gold-yellow colour when heated. The mineral did not occur in crystals, but in hexagonally bounded scales and plates. Later, it was found by HEDDLE in the island of Haaf-Grunay, Scotland[1], occurring in thin seams in serpentine and having a silvery white colour.

These two were as yet the only localities where the mineral had been met with. As neither locality had yielded determinable crystals, our knowledge of the mineral was rather defective.

Already several years ago I noticed, among the specimens that I obtained from the Mossgrufva in the Nordmark field, a mineral differing in appearance from every known mineral from that locality. It occurred in small, thin crystal scales with round or hexagonal outlines. However, it was met with so sparingly that it took me several years to collect sufficient material for a chemical examination. This examination proved the mineral to be identical with the pyroaurite from Långban, described by IGELSTRÖM.

The mineral occurs in fissures in the dolomite that includes most of the Mossgrufva minerals; the fissures also contain plenty of pyrochroite, mostly altered into manganite by oxidation and assumption of water. It is always developed in crystals. Being usually attached by one edge they are mostly only half-developed; crystal scales developed all around also occur. The colour of the crystals is yellow to yellowish brown; lustre on the basal plane pearly to greasy. Faintly translucent. Size of crystals : 0.5 to 1 mm. in diameter; thickness of scales only a fraction of a mm. As stated above, hexagonal boundaries are sometimes observable in the crystal scales, but in most instances they are greatly modified by truncating faces, giving the scales almost round or oval outlines.

The hardness of the mineral is between 2 and 3. Its specific gravity was determined as 2.07 at 18° C. by making a few crystal scales float in a solution of potassium mercuric iodide in water (Thoulet's solution).

When heated in a tube before the blowpipe, the mineral yields water. In the forceps it is infusible, but exfoliates. Even at the highest temperature the crystals retain their fine light-yellow colour; the darker crystals turn lighter; on the basal planes a vivid pearly lustre appears. After ignition the mineral is strongly magnetic. A trial showed also the unignited mineral to be distinctly, though feebly magnetic. By way of comparison a sample of the silver-white pyroaurite from Långban was examined, of which there is a specimen, labelled by the discoverer, in the cabinet of minerals of the university of Upsala. Also the Långban pyroaurite occurs in dolomitic limestone. It becomes gold-yellow on ignition, and is infusible. It is unmagnetic before being ignited, but turns magnetic on ignition. There is consequently a perfect agreement between

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[1] Mineral. Magaz. 2, 107. 1878.

the two minerals, except that the Mossgrufva mineral is distinctly, though feebly magnetic.

For the determination of the crystalline form a number of the thickest and most regular scales measurable by the goniometer were selected. The angle between the fundamental prism $\infty P\,(10\bar{1}0)$ and the pyramid $P\,(10\bar{1}1)$ was found to be, as a mean of five measurements on three different crystals,

$$\infty P : P = 76^\circ\,30',$$

from which is calculated the system of axes:

$$a : c = 1 : 3.6072.$$

It is remarkable that this system of axes agrees very closely with that given for chalcophanite, which is

$$a : c = 1 : 3.5267,$$

corresponding to a fundamental angle of

$$\infty P : P = 76^\circ\,12'.$$

Besides the two forms mentioned and the basal plane, there also occurs a prism of the third order truncating obliquely the edges of the fundamental prism. In order to determine it, the plane angles projected on the basal plane by these two prisms, were measured in the microscope. As a mean of numerous measurements these angles are

$$40^\circ\,20' \text{ and } 19^\circ\,40',$$

corresponding to a sign for the prisms:

$$\infty P\tfrac{3}{2}\,(21\bar{3}0),$$

which requires for these angles the values

$$40^\circ\,53\tfrac{1}{2}' \text{ and } 19^\circ\,6\tfrac{1}{2}'.$$

The occurring planes are then:

$oP\,(0001)$ dominating;
$\infty P\,(10\bar{1}0)$
$\infty P\tfrac{3}{2}\,(21\bar{3}0)$
$P\,(10\bar{1}1)$,

besides numerous other indeterminable faces, presumably most of them pyramids of the third order, which modify the hexagonal plates giving them a rounded shape.

As the prism $\infty P\tfrac{3}{2}$ regulary occurs only with 6 faces, one on each edge of the fundamental prism, this is evidently a case of pyramidal hemihedrism.

As the chalcophanite, with which the auropyrite agrees in length of axes, presents a rhombohedral hemihedrism, the two minerals, otherwise rather closely allied, cannot be said to be isomorphous.

Crystal scales placed under the microscope exhibit the following characters. In parallel polarized light there is imperfect extinction; and, when revolved, different parts of the crystal are extinguished in different positions. Light areas of irregular or triangular form are observable, radiating from various points or from the centre of the crystal. Only very thin scales show total extinction. In convergent polarized light an indistinct biaxialness is observed with a small axial angle, and the axial plane lying in different directions in different parts of the crystal. Only such very thin scales as show total extinction in parallel light are perfectly uniaxial in convergent light. It cannot, therefore, be doubted that the mineral is in fact to be regarded as uniaxial, and that the irregular extinction, as well as the small axial angle which most of the crystals present, must be referred to the optical anomalies so common in uniaxial minerals.

The power of refraction is feeble, scarcely exceeding that of Canada balsam, the double refraction negative and weak. For the sake of comparison I also examined the pyroaurite from Långban, the optical properties of which have never been stated. Scales of silver-white pyroaurite from that locality, whose behaviour before the blow-pipe was accounted for above, was found under the microscope to be perfectly opaque, neither direction of extinction nor axial image being observable. This is evidently due to the decomposition to which the mineral has been subject, and which is also manifested by the percentage of carbon dioxide which it contains. (The analysis by IGELSTRÖM gave 7.24 p. c. of $C. O_2$.)

To identify with certainty the mineral from the Mossgrufva, an analysis was made on the amount of material which it had been possible to procure: it did not exceed 0.0205 gr. (dried at 108° C.). For the analysis the material was dissolved in hydrochloric acid, when a small quantity was left insoluble. The water percentage was determined by ignition.

Analysis XVII. (R. Mauzelius.)

Pyroaurite from the Mossgrufva.

Gravity 2.07 at + 18° C.

	%	Molecular Ratio	
Insoluble	0.5		
Fe_2O_3	22.0	0.14	1
MnO	4.5	0.06	6.5
MgO	34.8	0.86	
H_2O	36.1	2.01	14.3
	97.9		

Alumina could not with certainty be shown to be present. The analysis agrees with the composition of pyroaurite and very nearly leads to the formula

$$Fe_2O_3 \,.\, 6\ (Mn,\ Mg)\ O \,.\, 15\ H_2O.$$

It should, however, be mentioned that the extremely small amount of material for the analysis made it impossible to decide whether the whole of Fe is present as a sesquioxide or, possibly, some part of it as a protoxide, in which latter case the formula would be a different one. As the mineral is distinctly magnetic, it is, indeed, probable that some portion of Fe enters as a protoxide. The state of oxidation of the Mn is also in doubt.

Summary. The mineral Pyroaurite, first discovered by IGELSTRÖM at Långban and, later, described by HEDDLE as occurring at Haaf-Grunay, Scotland, was found at the Mossgrufva in the manganiferous dolomitic formation noted for its richness in peculiar minerals, especially arseniates. The pyroaurite occurs in crystalline tables of round or hexagonal outline and yellow or yellowish brown colour, associated with pyrochroite, which has partially passed into manganite. The crystals, which offered an opportunity of determining the unknown crystalline form and optical properties of the mineral, belong to the pyramidally hemihedral division of the hexagonal system, with the system of axes $a : c = 1 : 3.6072$. Forms $0P$, ∞P, $\infty P\frac{3}{2}$, P. In polarized light the majority of the crystal scales exhibit such optical anomalies as differently orientired extinction, abnormal biaxialness; however, perfectly uniaxial individuals also occur. Power of refraction slight, double refraction feeble and negative. Hardness 2—3; spec. gravity 2.04. Faintly translucent; lustre pearly to greasy. Feebly magnetic, after ignition strongly magnetic. Infusible before the blowpipe. Composition nearly corresponding to the formula of the pyroaurite $Fe_2O_3 \,.\, 6\ MgO \,.\, 15\ H_2O$, with part of the MgO replaced by MnO.

12. Magnetite of Cubic Form from the Mossgrufva, Nordmark.

Pl. III. Figs 1—3.

Mr G. FLINK has described[1] the well-known crystals of magnetite from Nordmark. These crystals are distinguished by the dodecahedron (110) being always their dominant, often their only form. It is generally highly striated in the direction of the longer diagonal of the faces, which striation is due to alternation with the octahedron (111), which face is sometimes present as a slight triangular truncation of the trihedral angles of the dodecahedron. Sometimes the cube (100) occurs, truncating the etrahedral angles of the dodecahedron, as small four-sided planes, which

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[1] Mineralogiska Notiser 4 and 23; Bih. t. K. Sv. Vet. Akad. Handl. vol. 12, sect. II, 1886, and vol. 13, sect. II, 1887.

generally are extremely finely checkered diagonally. Mr FLINK, in mentioning this, remarks that the cube is a very rare form on magnetite, having only been observed on crystals from Vesuvius, Achmatowsk and Latium, and in these cases highly subordinate. Besides these forms, mr FLINK observed the tetragonal trisoctahedrons (211) and (311) and determined the new forms with the signs (310), (510), (950), (46. 9. 0), (92. 9. 9), and (55. 9. 9). The three lastmentioned are probably to be regarded as vicinal forms belonging to (510), (10. 1. 1), and (611) respectively. To mr FLINKs description of these crystals I have nothing to add; only with reference to the paragenesis of this kind of magnetite crystals it should be mentioned that they occur in fissures in the common massive magnetite, associated with crystallized, light-coloured diopside, tremolite and a third mineral, as yet not sufficiently examined, belonging to the chlorite group (probably ripidolite). Often these fissures are filled with calcite. Of less frequent occurrence in the same fissures are apatite, titanite, fluorite and pyrite. The diopside as well as the tremolite belong to an older generation than the magnetite; the chlorite and fluorite are younger, whereas the apatite and titanite seem to date from the same period as the magnetite. Of more recent formation is the calcite, which has in many instances completely filled up the fissures and druses, in which the magnetite and the other minerals have been formed.

This paragenesis greatly resembles the one presented by the occurrence of crystallized magnetite from Achmatowsk, Ural; the form and habit of the crystals, too, being exactly the same, as pointed out already by FLINK. According to KOKSHAROW[1] the magnetite of Achmatowsk occurs together with clinochlor (ripidolite) and light or white diopside, and is younger than, at least, the latter mineral, since he mentions that the magnetite crystals are often found implanted on the cracks of the white diopside. Consequently both paragenesis and succession are the same as at Nordmark.

Widely different from this is the paragenesis that characterizes the other kind of magnetite, of which account is to be given in this paper, and the dominant form of which is the cube. Magnetite crystals of this kind seem to be extremely rare, having as yet been found only in a few specimens. Two such specimens, somewhat different from one another, are lying before me. One of these, which I designate as N:r 1, belongs to the Mineralogical Department of the Riksmuseum (State Museum) and has been kindly placed at my disposal by its director, baron A. E. NORDENSKIÖLD. The other (N:r 2) I have acquired from mr G. FLINK. The source of both is the Mossgrufva of the Nordmark mines.

The main constituent of the former specimen is impure calcite. It consists of symetrically arranged bands, which structure shows it to have been filling a fissure. The side portions, which have been nearest to the

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[1] Materialien z. Miner. Russlands, Vol. III, page 55.

walls of the fissure, form parallel bands of brownish red calcite, strongly coloured with ferric oxide. These pass into a purer, crystalline calcite of which the main mass of the specimen consists. The breadth across the fissure has been about 30 to 40 mm. In several places both in the central and in the side portions there are small drusy cavities, 20 to 50 mm. in extent.. The walls of these cavities are chiefly lined with crystals of calcite of an acute scalenohedric type (probably R 5 or R 7), 3 to 5 mm. in length. Besides these calcite crystals the drusy cavities also contain fluorite in green and violet colours, sometimes crystallized in indistinct octahedrons with rough, apparently corroded faces, and the crystal angles rounded. The crystals of fluorite attain a size of about 3 to 4 mm. The fluor-spar seems to be the youngest of the minerals in these druses: it is evidently younger than the scalenohedric calcite and also, as will soon be seen, than the cubic magnetite.

In these druses occur crystals of magnetite of perfectly cubic form. The length of their edges is 0,5 to 3 mm. No other form than the cube is observable, not even as the slightest truncation of edges or angles, which are everywhere sharp. The faces are not perfectly smooth, but present a system of lines intercrossing at right angles, running parallel to the edges of the cube. These lines form raised ridges; hence they cannot be the result of etching or corrosion, in which case they would form grooves. Twin crystals with an octahedral plane as composition face are common. Also trillings and more complex aggregates occur.

The crystals of magnetite occur implanted in the scalenohedrons of calcite or on their surfaces. They have, consequently, formed simultaneously with, or later than the calcite. The fluorite, on the other hand, which as massive parties fills up the central portion of the fissure formation, or appears as crystals in the still open parts of the drusy cavities, is generally younger than the magnetite. The cubes of magnetite are aggregated in large numbers, where the calcite borders upon the mass of fluorite, sometimes even on the surface of the fluorite crystals. From this it appears, that no very distinct periods of formation can have existed, but that the formation of the magnetite has been in progress simultaneously with the deposition of the calcite as well as with that of the fluorite. On the whole, however, the calcite seems to be the oldest, and the fluorite the youngest of the minerals.

The second specimen shows a somewhat different character. However, its main mass consists of the dolomitic limestone, that appeared in the Mossgrufva in association with the occurrence of manganese. It is in part of a brecciated character. The specimen shows an open drusy cavity, about 5 cm. in length, lined with crystallized minerals, *viz.* calcite, fluorite, hematite and magnetite. The fluorite resembles that of the specimen just described, and occurs in better developed crystals than on that specimen. The cube and the dodecahedron are dominant. Here, too, the fluorite presents a corroded appearance. The hematite occurs abundantly in highly brilliant rhombohedral crystals 1 to 3 mm. in size. Its forms are very simple and exhibit only the positive and negative fundamental rhombohedrons, *r* $(10\bar{1}1)$, *η* $(01\bar{1}1)$, the scalenohedron *n* $(22\bar{4}3)$, and a series of undeterminable scalenohedrons lying in the zone $\{r\ n\}$, which cause a fine striation of the face *r* and sometimes make it rounded. It is remarkable that on these crystals the base *c* (0001) is absent. It is generally the case with hematite that the base, when absent, is replaced by some low rhombohedrons, *n* $(10\bar{1}4)$ or the like, but this is not the case here, where the crystals terminate in the pointed fundamental rhombohedrons. This also gives the hematite crystals of this formation a peculiar habit[1].

The magnetite crystals, which occur more sparingly than the hematite, are of two kinds. One is in perfect accordance with those above described as occurring on the specimen N:r 1. They consequently only present the form (100) with sharp edges and angles. The other kind shows the combination (100) (101), with the first form dominating. It is worthy of note, that the latter kind of crystals always exhibit a rough or dull surface, looking as if it were etched, and rounded edges, which might induce one to suppose, that the dodecahedral faces owed their origin to the corrosion and etching of crystals of the first kind, if such a supposition were not contradicted by the fact that crystals of both kinds occur together, and the difficulty of explaining why only some of the crystals had been attacked by corrosion, and not all.

As to the relative age of the minerals in the drusy cavity, the calcite is also here the oldest, though some of the magnetite crystals are imbedded in the calcite in a way that proves them to have been formed, while the calcite was in course of deposition. The fluorite is obviously younger than the calcite, and, on the whole, contemporaneous with the magnetite. The youngest of all the minerals is the hematite.

To satisfy myself that the mineral really was magnetite, a few crystals were detached from the specimen N:r 1 and subjected to the following examination. The establishment of the specific gravity of the mineral was thought to be of prime importance. It was determined by four weighings in benzole. Owing to the small amount of material available — 0.0245 gr. — the result varied from 4.93 to 5.24; the mean of the four determinations being 5.08. As the specific gravity of the magnetite is 4.9 to 5.2, there is consequently full accordance. After dissolving the mineral in HCl the percentage of iron was determined quantitatively and found to be 73.5 p. c.; $Fe_3 O_4$ contains 72.4 p. c. of Fe. In the filtrate after Fe no

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[1] To the crystals of hematite from the Mossgrufva, described by FLINK, these crystals bear but little resemblance. The former have the base (0001) strongly developed, the negative fundamental rhombohedron is absent from them, whereas they exhibit a combination of the following forms: *c* (0001), *r* $(10\bar{1}1)$, *e* $(01\bar{1}2)$, *a* $(11\bar{2}0)$, *t* $(21\bar{3}4)$, r^2 $(06\bar{6}5)$, *i* (4265), and *χ* $(12\bar{3}2)$. FLINK, Bih. t. Kongl. Sv. Vet. Akad. Handl., Vol. 13, sect. 2, page 33, and ARZRUNI, Zeitschr. für Krystallographie, Vol. 18, page 55.

other substance could be identified. It was, therefore, considered as settled that the crystals really are magnetite.

When magnetite of such an uncommon form is met with, one, of course, feels inclined to think that the mineral is not original, but a pseudomorph. In this case pyrite is the mineral one would first think of as having changed to magnetite, although no traces of pentagonal hemihedrism have been observed. An examination of the two specimens in this respect has, however, convinced me that in this case there is no pseudomorphism, and that the mineral is original.

It is evident that the uncommon form of the magnetite is in the present case most closely connected with the paragenesis and succession of the minerals. The magnetite, when presenting the appearance common at Nordmark, is always older than the calcite which fills the fissures, and, likewise, older than the fluorite with which it is sometimes associated. The *cubic* magnetite, on the other hand, is for the most part younger than the calcite and contemporaneous with or, in some cases, younger than the fluorite.

Both the peculiar form of these magnetite crystals and the uncommon succession make it probable, that in this case the magnetite has formed in a way quite different from that, in which the common crystals of magnetite at Nordmark have grown. Its association with fluorite in the same generation suggests a mode of formation through volatile compounds of iron, analogous to that of the sublimated magnetites belonging to the pneumatolytic formations (BUNSEN). This explanation is, however, made improbable by being almost incompatible with the presence of the calcite as the substratum on which the crystals have grown. Nor is such an hypothesis supported by the geometrical form either of the magnetite or of the hematite. For the sublimated magnetite presents the forms 0 and ∞ 0, and the hematite always has the basal plane strongly developed, so that the crystals often are tabular parallel to (0001). This is quite contrary to the form of the hematite which accompanies the magnetite, it being, as has been shown, characterized by the absence of (0001).

It seems more probable, that also in this case the magnetite etc. have originated from a solution, and that the nature of the solution or some one of the substances which together with the iron have been contained in it have caused the separation in such an extraordinary form.

It may be added that, as far as I have found from the litterature, cubic magnetite has been met with only twice before, *viz.* at Kraubat in Styria[1] (with chromite in serpentine) and in New Zealand[2].

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[1] ZEPAROWICH. Min. Lexicon Oester. Vol. I, page 254; Vol. II, page 191.

[2] GLADSTONE, Chemical News I, page 116.

13. **Safflorite from Nordmark.** Pl. IV. Fig. 6, 7.

At the Kogrufva in the Nordmark field, associated with the minerals of the humite group, a mineral has been met with which on examination has been found to be safflorite. This find having afforded an opportunity of determining the hitherto unknown crystalline form of the safflorite, a description of it is given here.

The mineral in question occurs imbedded in the dolomitic calcite which accompanies the iron ore in this part of the mine. Associated minerals are chondrodite and its serpentinous alteration products, tremolite in long, acicular prisms, and magnetite, the latter generally in crystalline masses. A usual associate is also a brownish yellow, coarsely crystalline blende. Of these minerals the magnetite, the humite minerals, and the tremolite are the oldest and evidently older than the calcite, against which they present idiomorphic crystalline boundaries. The safflorite, as well as the zinc-blende, seems to belong to younger mineral generation; both occur imbedded in the calcite, the former in irregular nodules, the latter with crystalline boundaries.

The mineral occurs in most instances as uncrystallized masses of tin-white colour and uneven or granular fracture. Sometimes the fracture presents segregation faces with fibrous texture and a darker, iridescent tarnish. Hardness 5.5. Brittle. Streak greyish black. Very rarely appear crystals shooting out as pointed projections from the larger, uncrystallized masses. The crystals form groups, one of which is represented in fig. 6, Pl. IV; the size of the crystal individuals is 3—10 mm.

The crystals have a prismatic habit with pyramidal termination. Taking the direction in which the crystals are most developed as vertical axis and the sole occurring pyramid as fundamental pyramid, the system of axes will be

$$a : b : c = 0.5685 : 1 : 1.1180$$

which is calculated from the fundamental angles

$$\begin{aligned} o\,(111) : o\,(\bar{1}11) &= 105^\circ\,20' \\ e\,(110) : e\,(1\bar{1}0) &= 59^\circ\,14'. \end{aligned}$$

With this position of the crystal the occurring faces will have the following signs:

$$\begin{aligned} a &= \infty \bar{P} \infty \ (100) \\ e &= \infty P \quad\ \ (110) \\ d &= \breve{P} \infty \ (011) \\ f &= \bar{P} \infty \ (101) \\ o &= P \quad\ \ (111). \end{aligned}$$

As will be seen from fig. 7, Pl. IV, which represents a crystal of typical development, the *e* faces of the vertical prism are the most dominant; next come the macropinacoid *a* and the fundamental pyramid *o*; the two domes *d* and *f* are very subordinately developed and not measurable. The measured and calculated angles are given in the following table of angles:

	Observed	Calculated
$o\,(111) : o\,(\bar{1}11)$	105° 9′	*105° 20′
$o\,(\bar{1}\bar{1}1) : o\,(1\bar{1}1)$	105 31	» »
$o\,(111) : o\,(1\bar{1}1)$	54 15	53 44
$o\,(\bar{1}11) : o\,(\bar{1}\bar{1}1)$	53 38	» »
$o\,(\bar{1}11) : o\,(1\bar{1}1)$	132 43	132 18
$o\,(111) : o\,(\bar{1}\bar{1}1)$	132 47	» »
$e\,(110) : e\,(1\bar{1}0)$	59 28	*59 14
$e\,(\bar{1}10) : e\,(\bar{1}\bar{1}0)$	59 1	» »
$e\,(\bar{1}10) : o\,(\bar{1}11)$	22 37	23 51
$e\,(1\bar{1}0) : o\,(1\bar{1}1)$	23 5	» »
$e\,(110) : o\,(111)$	23 40	» »
$e\,(\bar{1}\bar{1}0) : o\,(\bar{1}\bar{1}1)$	23 17	» »
$d\,(011) : d\,(0\bar{1}1)$		96 22
$f\,(101) : f\,(\bar{1}01)$		126 6

The position chosen above gives the simplest symbols for the faces and is the most natural, if the relation of the mineral to other species is not considered. To make this relation appear more clearly, it will be necessary to change the position. As is known, all minerals of this group, crystallizing in the orthorhombic system, marcasite, löllingite, arsenopyrite, and glaucodot, present a zone with prismatic angles approximating to 60° and 120°. Thus marcasite shows the angle 116° 20′, löllingite 123° 3′, arsenopyrite 120° 38′, and glaucodot 119° $35\frac{1}{2}'$[1]. To this angle corresponds on the safflorite from Nordmark the angle 120° 46′. With the position generally chosen for the crystals of the minerals of this group the said prism is made a macrodome. Giving the safflorite a corresponding position, we have to interchange the axes *b* and *c*. The system of axes

$$a : b : c = 0.5685 : 1 : 1.1180$$

is then exchanged for the new system

$$\begin{aligned} a^1 : b^1 : c^1 &= 0.5685 : 1.1180 : 1 \\ &= 0.5085 : 1 \quad : 0.8944. \end{aligned}$$

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[1] These figures are quoted from Dana's System 6th Ed., p. 94—101.

To show the agreement with the system of axes of the arsenopyrite, we multiply the lengths of the three axes by $\frac{4}{3}$; the system of axes may then be written:

$$a^1 : b^1 : c^1 = 0.6780 : \tfrac{4}{3} : 1.1926$$

while that of the arsenopyrite is

$$a : b : c = 0.6773 : 1 : 1.1882.$$

There is consequently perfect agreement with regard to the *a*- and *c*-axes, whereas the *b*-axis of the safflorite is to the corresponding axis of arsenopyrite as 4 to 3.

With the position and lengths of axes given last the symbols of the occurring forms are as follows:

$$\begin{aligned} a &= \infty \bar{P} \infty \; (100) \\ e &= \bar{P} \infty \; (101) \\ d &= \check{P} \infty \; (011) \\ f &= \infty P \; (110) \\ o &= P \; (111). \end{aligned}$$

The mineral fuses before the blowpipe and gives reactions for As and Co. Easily and completely soluble in nitric acid.

To ascertain the chemical composition, a quantitative analysis was made by mr R. MAUZELIUS.

Analysis XVIII. (R. Mauzelius.)

Safflorite from Nordmark.

Gravity = 7.41 at 16° C.

	%	Molecular ratio	
Pb[1]	0.33	0.0016	0.4987
Fe	15.28	0.2729	
Co	12.99	0.2202	
Ni	0.20	0.0034	
As	71.13	0.9484	0.9697
S	0.68	0.0213	
	100.61		

The ratio of Fe + Co + Ni + Pb to As + S is = 1 : 1.95, to which corresponds the formula

$$(Fe, Co)\,As_2$$

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[1] together with some Cu.

The ratio of Fe : Co being nearly 1 : 1, the formula may also be written

$$\mathrm{Fe\,As_2 \,.\, Co\,As_2}$$

which corresponds to one molecule of löllingite and one of safflorite.

As is known, the orthorhombic safflorite has the same chemical composition as the isometric smaltite; the minerals differ not only in crystalline form, but also in specific gravity, which for safflorite is higher than for smaltite. DANA, quoting BREITHAUPT, states the sp. gravity of safflorite to be 7.123—7.129 and that of smaltite 6.4—6.6[1]. Therefore, when occurring uncrystallized, it is only by their specific gravity that the minerals can be distinguished. On account of this character DANA, in the sixth edition of his System, refers to safflorite a mineral from Tunaberg with the high specific gravity of 7.131[2]. This is the only Swedish locality for safflorite hitherto known. It is remarkable that at Tunaberg both kinds of $\mathrm{(Fe, Co)\,As_2}$ occur.

The mineral, an analysis and description of which has been given above, is, as appears from the foregoing, near löllingite in composition or holds an intermediate position between safflorite and löllingite. Also cobaltiferous löllingites occur, but it seems to have been customary to refer finds, containing so large a percentage of cobalt as the mineral here described, to safflorite. I consider myself the more justified in so doing, as the crystalline form differs from that of löllingite in habit as well as in lengths of axes.

Summary. The mineral here described occurs at the Kogrufva, Nordmark, associated with the minerals of the humite group, altered tremolite, and light-coloured blende, in a dolomitic calcite. It has the character of the safflorite, is usually uncrystallized, but sometimes occurs in crystals. Placing the prismatic zone vertically, the system of axes is

$$a : b : c = 0.5685 : 1 : 1.1180$$

which, to show the accordance with the other orthorhombic minerals of this group, may also be written $= 0.6780 : \frac{4}{3} : 1.1926$.

The composition of the mineral is $\mathrm{(Fe, Co)\,As_2}$ or nearly $\mathrm{Fe\,As_2 . Co\,As_2}$; it consequently falls, chemically, between löllingite and safflorite.

14. On the Richterite of Breithaupt and on Soda Richterite[3].

1. On the Richterite of Breithaupt.

The name Richterite (after THEODOR RICHTER, Professor at the Mining Academy of Freiberg) was given by BREITHAUPT in 1865 to a

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[1] However, the analyses given by DANA show greater variations, *viz.* for safflorite from 6.7 to 7.28, and for smaltite from 6.11 to 6.49.

[2] Analyzed by WARRENTRAPP and described in Pogg. Ann. Vol. 48, p. 505, 1839.

[3] The main substance of this article has already been published in Geol. Fören. Förhandl. Vol. 12, p. 604 and Vol. 14, p. 253.

mineral from Långban, characterized as follows[1]: »Die Krystallisation ist holorhombisch, das primäre Prisma $\infty P = 133^\circ 38'$, mit einer Differenz der Beobachtungen von höchstens 6 Minuten. Zarte bis nadelförmige Krystallen zeigen dies, das brachydiagonale Flächenpaar $\infty P \breve{\infty}$ und zwei Domen zur Makrodiagonale, ein steiles, etwas glänzendes und ein sehr flaches, nur schimmerndes, beide nicht messbar. — — — Specifischer Gewicht = 2.826.» No quantitative analysis of the mineral was given, only some qualitative determinations by Prof. Richter, showing the chief constituents, besides silicic acid, to be manganese protoxide, magnesia, lime, and soda. Breithaupt concludes his notice thus: »Nach den äusseren Kennzeichen steht dieses Mineral, welches selten vorzukommen scheint, keinem bekannten anderen besonders nahe.»

Already in 1863, however, Michaelson had analyzed and described a similar mineral from the Långban mines[2].

Later, Igelström[3] expressed the opinion, that the mineral analyzed by Michaelson was identical with the richterite of Breithaupt, against wich, however, the latter protested[4], declaring, that a mineral (obtained from Igelström), which had been sold under the name of richterite by Dr. Kranz, the wellknown dealer in minerals at Bonn, was not the mineral that he (Breithaupt) had designated by that name. At the same time Breithaupt repeats that the real richterite has a prismatic angle of 133° 36′ and a specific gravity = 2.826—2.844, while he declares the other mineral to be in reality a member of the amphibole group, having a cleavage-angle of about 124° and sp. grav. = 3.067—3.068.

As, however, the mineral whose characters had thus been twice given by Breithaupt was no more met with, while the mineral of the amphibole group found by Michaelson at Långban and by Igelström at Pajsberg was more and more commonly observed, different opinions gradually arose as to what mineral was to be properly understood by the name richterite. J. D. Dana, for instance, in the 5th ed. of his universally esteemed »A System of Mineralogy», mentions two minerals by the name of richterite[5] *viz.* a pyroxene mineral (presuming the prismatic angle 133° 38′, given by Breithaupt, to correspond to the angle 133° 33′ between the prism and the brachypinacoid in the pyroxenes) and an amphibole mineral, for wich he quotes the analysis of Igelström.

Flink, to whom we are indebted for the first somewath detailed statements about the crystalline form of the richterite, point out that the mineral from the Långbanshytta »now going by the name of richterite is not the same mineral as that to which Breithaupt applied the name.»

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[1] Berg- und Hüttenm. Zeitung 1865, p. 364.

[2] Kongl. Vet. Akad. Öfvers. 1863, p. 199.

[3] Berg- u. Hüttenm. Zeitung 1866, p. 263, öfvers. K. V. A. 1867, p.

[4] Berg- u. Hüttenm. Zeitung 1866, p. 148.

[5] Dana, A System of Mineralogy, 5th ed., p. 215 and 234.

He, therefore, proposes to use the name only on the supposition that »the original material of BREITHAUPT is no longer extant.»

The same doubt as to what mineral the name richterite is to be applied to, may be the reason, why even in such handbooks as lay claim to relative completeness (*e. q.* Naumann-Zirkel's 12th ed.) the name richterite is not found.

This was the state of the question, when in 1892 the investigation of a mineral closely allied to richterite induced me to undertake an inquiry about the nature of the mineral originally named richterite by BREITHAUPT, and its relation to the richterite of MICHAELSON and IGELSTRÖM.

For this purpose I applied to Professor A. WEISBACH, who, as the immediate successor of BREITHAUPT, is now occupying the chair of mineralogy at the Freiberg Mining Academy, for information as to whether the original material of BREITHAUPT's richterite was still to be found in the cabinet of the Academy. Eve long, I was favoured with the answer that the said material had been found, and a piece of it was sent me, together which BREITHAUPT's original label with the words »von Longbanshytta in Wermeland, Richterit, Brht»[1].

The piece contains yellow prisms of a mineral perfectly corresponding, as regards the exterior characters, to BREITHAUPT's description of richterite, except that no domes or terminal planes of any kind were observable; they were inclosed in a compact rhodonite. The most important character, however *viz.* the angle of cleavage, which determines the systematical relations of the mineral, was found not to agree with the angle given by BREITHAUPT, but with that of amphibole or, strictly speaking, to be

$$56^\circ 24' \ (123^\circ 36')$$

with a variation of a few minutes on either side in different cleavage fragments[2].

A determination of the angle of extinction in the plane of symmetry gave an angle with the vertical axis of 16°, showing the monosymmetric character of the mineral. Lastly, the specific gravity was found to be = 3.08 instead of 2.826, as it was given by BREITHAUPT[3].

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[1] In this place I take the opportunity of publicly expressing my grateful thanks to Professor WEISBACH for his complaisance in placing the original material of BREITHAUPT at my disposal.

[2] When he described the richterite, BREITHAUPT was already 74 years old, and his sight so weak, that he was compelled, shortly after to submit to an operation of his eyes. (Communication from Prof. WEISBACH.) Therefore, an error of 10° (133° 38' instead of 123° 36') in reading off the goniometer is easily accounted for and very excusable.

[3] A. HAMBERG has called attention to the probability of Breithaupt having made a mistake in putting down the specific gravity of richterite. "The specific gravity, 2.826, found by Breithaupt for richterite, is also found under his mineral, "snarumite", where, no doubt, it is more applicable. Probably BREITHAUPT has been simultaneously engaged in the examination of both minerals, as the description of the one is immediately followed by that of

The original richterite of BREITHAUPT having thus been found to agree in every respect with the mineral described by MICHAELSON, IGELSTRÖM and FLINK, and the considerable discrepancy between the descriptions being evidently due to errors, we need no longer hesitate in applying the name richterite to all these finds. The mineral from Långban described by BREITHAUPT was evidently identical with the one previously analyzed by MICHAELSON and afterwards examined crystallographically by FLINK.

2. Soda Richterite from Långban.

Of late years a mineral has been met with at the Långban mines in Wermland, differing in outward appearance from the hitherto known minerals from that locality. It occurs, associated wtih massive rhodonite, in rather coarsely crystalline, short columnar aggregates of a beautiful azure-blue, sometimes grey to greyish-violet colour. An examination proved this mineral to be closely related to richterite, as a variety of which it may be justly regarded.

The mineral does not occur in crystals, and therefore the only crystallographical determination possible was a measurement of the angle between the very distinct prismatic cleavages, which angle was found to be, as a mean of several measurements:

$$123^\circ\ 33'.$$

This angle characterizes the mineral as an amphibole. Two other, less prominent cleavages have also been observed, one of which is distinct and corresponds the clinopinacoid $\infty \breve{P} \infty$ (010), the other is indistinct and corresponds to the orthopinacoid $\infty \bar{P} \infty$ (100). Hardnes 5—6; fracture crystalline. The mineral is translucent; lustre glassy. Thin sections under the miscroscope are perfectly transparent and colourless, showing the cleavages of amphibole and, in polarized light, very brilliant interference colours.

Sections cut parallel to $\infty \bar{P} \infty$ (100) show extinction parallel to the vertical axis, and in convergent polarized light the emersion of one of the optic axes is visible. Plates parallel to $\infty \breve{P} \infty$ (010) of the blue mineral show extinction at an angle of 15° 40′ to the vertical axis; similar plates of the greyish-violet variety extinguish at 17° 15′ to the vertical axis. The optic axes lie in the plane of symmetry, and the acute bisectrix is negative. The measurement of the acute axial angle in air has given for the blue variety approximately

$$2\ E_r = 131^\circ - 136^\circ$$

The dispersion of the optic axes is $\varrho < v$.

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the other, and by on inadvertency the specific gravity of the snarumite may have been given also for the richterite". A. HAMBERG, Geol. Fören. Förh. Vol. 14, p. 600.

Before the blowpipe the mineral, even in large splinters, fuses easily to a brown, transparent glass. Insoluble in acids. Two analyses were made, one of the blue, one of the grey variety.

Analysis XIX. (R. Mauzelius.)
Blue Soda Richterite from Långban.
Gravity 3.05 at + 14° C.

	%	Molecular ratio		
SiO_2	56.25		0.931	1
FeO	0.15	0.002		
MnO	6.49	0.091		
CaO	5.44	0.097		
MgO	21.89	0.543	0.937	1.01
K_2O	1.60	0.017		
Na_2O	6.17	0.100		
H_2O	1.56	0.087		
F	0.15		0.008	
	99.70			
O corresponding to F_2	0.06			
	99.64			

Analysis XX. (R. Mauzelius.)
Greyish-violet Soda Richterite from Långban.
Gravity = 3.10 at 16° C.

	%	Molecular ratio		
SiO_2	54.76		0.907	1
FeO	0.21	0.003		
MnO	12.71	0.179		
CaO	5.83	0.104		
MgO	17.82	0.442	0.965	1.06
K_2O	1.65	0.018		
Na_2O	4.02	0.065		
H_2O	2.77	0.154		
F	0.09		0.005	
	99.86			
O corresponding to F_2	0.04			
	99.82			

The analyses were made by the usual methods. The water was determined directly by weighing.

As appears from the figures for the respective ingredients, both analyses are in close agreement with the metasilicate formula $\overset{II}{R} . Si O_3$, on condition that the water present be calculated as H_2 replacing a metal. That the water shown by both analyses must be regarded as an essential constituent of the mineral, is begond doubt, considering the fresh and undecomposed state of the material analyzed and the high temperature required for driving off the water.

The formula can be divided into the two compounds

$$(Mg, Ca, Mn)\ Si O_3 \text{ and}$$
$$(Na, K, H)_2\ Si O_3.$$

Of these two silicates the former has a composition analogous to the common actinolite silicate, while the other, the alcaline, is a silicate characteristic of the richterite, being found in no other kind of amphibole. The presence of this silicate entitles the richterite to an independent place in the series of amphiboles, a place as yet not allowed it in the Manuals of Mineralogy.

The non-aluminous amphiboles have been referred by some authors to the formula

$$Ca\, Mg_3\, Si_4\, O_{12},$$

in which Ca and Mg could be in part replaced by various substances. It may be pointed out in this place that it seems impossible to make the analyses given above agree with this formula. If K_2, Na_2 and H_2 are supposed to replace Ca, and Mn and Fe to replace Mg, which suppositions certainly are the most natural, the ratio of (Ca, K_2, Na_2, H_2) to (Mg, Mn, Fe) in both analyses will be very nearly 1 : 2. The approximate formula would then be:

$$(Ca, K_2, Na_2\ H_2)\ 2\ (Mg, Mn, Fe) . 3\ Si O_3.$$

In the above it has been assumed that the water is present as H_2 combined with $Si O_3$ in the same way as the metals. As far as I know, this is the first time that water has been directly shown to be present in a perfectly fresh amphibole. The correctness of the wiew with regard to the place of the water in the molecule is confirmed by the following test. A weighed quantity of powdered blue richterite was subjected to strong heat so that it sintered; the loss on ignition amounted to 3.37 p. c. From the powder thus treated 13.38 p. c. of $Si O_2$, corresponding to 3.36 p. c. of $H O_2$ could be extracted by a soda solution. This seems to indicate that through the ignition, at the escape of $H_2 O$, the molecule was split up and free $Si O_2$ separated.

The contrary view, according to which the water is present as hydroxyl combined with the metal atoms and abating their value of saturation, is less probable, because it would make the molecular relation, which now leads to a very simple formula, rather complicated.

Finally, it ougth to be mentioned in this place that minerals from Långban, very closely allied to the soda richterite here described, have been previously described. In 1875 N. ENGSTRÖM analyzed and described a »coarsely to finely crystalline, white, sugar-like mineral with the hardness 4—4.5 and gravity 3.09». The mineral was found to contain a small percentage of Li; for the sake of comparison, its analysis is given below under *A*. An other mineral was described in the same year by N. O. HOLST (who gave it the name marmairolite and considered it a variety of enstatite). It occurs in minute crystalline grains and scales disseminated through a limestone containing also carbonates of manganese and lead. Spec. grav. = 3.07. Analysis given under *B*.

	A.	*B.*	
SiO_2	53.28	56.27	
Al_2O_3	2.31	—	
MnO	7.54	4.86	
FeO	1.62	2.03	
CaO	8.43	6.33	
MgO	19.20	21.36	
Li_2O	0.66	—	
K_2O	—	1.89	
Na_2O	6.33	5.94	
H_2O	0.71	0.90	(loss on ignition)
	100.08	99.58	

It is evident that these two minerals are soda richterites, while the original richerite, analyzed by MICHAELSON, with its amount of 6.37 p. c. K_2O, is a potash richterite.

To judge from the analyses hitherto made, the soda richterites are characterized by lighter colours, from white to greyish-violet and azure-blue, while the richterite proper is yellow to yellowish-brown. Only the latter seems to occur in crystals, while the soda richterite forms finely or coarsely crystalline or columnar aggregates.

15. Urbanite, a New Member of the Pyroxene Group.

1. Urbanite from Långban. Pl. III, Fig. 4—6[1].

In 1892 I received from mr G. FLINK a couple of specimens of a very beautifully crystallized mineral from Långban, designated by mr FLINK

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[1] The maine substance of this article has already been published in Geol. Fören. Förh. Vol. 14 p. 251, 1892 and the characters of the new species Urbanite as well as the name are there first given.

as »iron schefferite». A chemical and crystallographical investigation of this mineral has, however, given the result that it is not a schefferite, but must be designated as a new species, though allied to the schefferite.

The mineral occurs in the finely granular hematite of the Långban mines as seems and veins of a few mm, or 1 cm. at most, in thickness. Sometimes these seems widen, enclosing drusy cavities filled with calcite, in which cavities the mineral is found as very fine crystals 1 to 3 mm in size. The crystals are brownish black or nearly purely black, sometimes faintly translucent; the crystal faces very brilliant, streak light brown.

The hardness is about 5. The mineral presents two distinct prismatic cleavages and one less distinct parallel to the basal plane.

The crystallographical examination shows that the mineral crystallizes in the monoclinic system with the following system of axes:

$$a : b : c = 1.1009 : 1 : 0.6058$$
$$\beta = 72^0\,7'.$$

The following forms have been observed:

$a = \infty \bar{P} \infty\ (100)$
$b = \infty \check{P} \infty\ (010)$
$m = \infty P\ (110)$
$p = + \bar{P} \infty\ (10\bar{1})$
$r = \frac{5}{3} \check{P} \infty\ (053)$
$s = + P\ (11\bar{1})$
$u = - P\ (111)$
$o = + 2P\ (22\bar{1})$
$n = - 2P\ (221),$

to which are to be added two forms, which cannot be determined with certainty, *viz.*

$$x = \tfrac{3}{2}\bar{P}\tfrac{3}{2}\,(32\bar{2}) \quad \text{or} \quad \tfrac{4}{3}\bar{P}\tfrac{4}{3}\,(43\bar{3})$$
$$y = \tfrac{3}{2}\bar{P}6\,(61\bar{4}).$$

Of these forms the positive and negative fundamental pyramids $\pm P$ are dominating; their basal edges are truncated by ∞P and $\pm 2P$. The faces of $\pm P$ are brilliant and well developed, and so are also ∞P and $\infty \bar{P} \infty$. The faces of the other forms are partly dull, partly so small that they do not give good reflexes. The pyramid x lies in the zone $\{100 : 11\bar{1}\}$; the angles obtained were

$$a : x = 67^0\,46'$$
$$a : x_1 = 67^0\,15.$$

This pyramid x should consequently correspond most nearly either to $\frac{3}{2}\bar{P}\frac{3}{2}\,(32\bar{2})$, whose angle $a(100) : (32\bar{2}) = 65^0\,0'\,30''$, or to $\frac{4}{3}\bar{P}\frac{4}{3}(43\bar{3})$, whose angle $a\,(100) : (43\bar{3}) = 69^0\,1'\,20''$. Also the two small faces occurring between the pyramid *x* and *a* (100) are not to be determined with certainty, but seem to correspond mast nearly to the pyramid $\frac{3}{2}\bar{P}6$.

From this description of the crystals, and still more from the figures (4—6 Pl. III) it is obvious that in habit and form of development the crystals present no resemblance to the crystals of schefferite. In his description of the schefferite from Långban FLINK points out that the basis is almost always the most dominating face of the crystals and that they are aften tabularly developed parallel to it. That surface is totally absent from the urbanite. Another point of difference is that, while twinning is common in schefferite, it has not been observed in urbanite. Also with the iron schefferite of Långban and Pajsberg there is but little agreement as to crystal habit, the crystals of the latter mineral being characterized by a prismatic development of the zone *b* (010) *s* $(11\bar{1})$ *p* $(10\bar{1})$, which has not at all been observed in the crystals of urbanite.

The measurements of angles made on two crystals are given in the following table.

Table of Angles.

	Measured.	Calculated.
u $(1\bar{1}1)$: *m* $(1\bar{1}0)$	44° 8′	44° 5′
u (111) : *m* (110)	44 9	» »
u $(1\bar{1}1)$: *s* $(\bar{1}11)$	76 30	76 49
u (111) : *s* $(\bar{1}\bar{1}1)$	76 33	» »
u (111) : *u* $(1\bar{1}1)$	48 22	48 28
u (111) : *s* $(11\bar{1})$	76 30	76 49
s $(1\bar{1}\bar{1})$: *m* $(1\bar{1}0)$	59 22	59 6
s $(11\bar{1})$: *a* (100)	77 16	77 40
m $(1\bar{1}0)$: *a* (100)	46 20	46 20
m (110) : *a* (100)	46 17	» »
o $(2\bar{2}\bar{1})$: *m* $(1\bar{1}0)$	35 31	35 16
n $(2\bar{2}1)$: *m* $(1\bar{1}0)$	29 48	28 25
b (010) : *r* $(0\bar{5}3)$	41 47	41 43
r (053) : *r* $(0\bar{5}3)$	97 23	96 35

Before leaving the subject of the geometrical development of the mineral a comparison with related minerals with respect to the axial constants may be in place. Those of diapside, schefferite, urbanite, and acmite are, therefore, here given together.

	Diopside Nordmark, type V	*Schefferite*	*Urbanite*	*Acmite*
$a:b:c=$	1.0921:1:0.5893	1.1006:1:0.5926	1.1009:1:0.6058	1.0996:1:0.6012
$\beta=$	74° 12¾′	73° 53′	72° 7′	73° 11′.

From this comparison it is obvious that, as regards both the axial angle β and the length of the c-axis, the urbanite is more closely allied to acmite than to schefferite, which is also the case with respect to the physical properties and the chemical composition.

Sections cut parallel to the orthopinacoid $a(100)$ or, in general, parallel to the zone of the ortho-axis show symmetrical extinction. Sections parallel to the plane of symmetry show oblique extinction making with the prismatic cleavages an angle which, measured with BERTRAND's ocular, is found to be $+16^0$.

Further examination of the same plate in parallel light has shown that the direction of extincton that makes on angle of 16^0 with the c-axis, corresponds to the axis of the greatest elasticity, that is, to $\mathfrak{a}$.

Thus, the optical orientation is

$$\mathfrak{a} \wedge c = +16^0.$$

Considering that the corresponding angles of extinction of other pyroxenes are:

Diopside . . . . $\mathfrak{a} \wedge c = -36^0$ to -52^0,
Schefferite . . . . » $= -45^0\,34'$
Iron Schefferite . . . . » $= -31^0$ to -43^0
» » (Långban) » $= -19^0\,51'$
Acmite . . . . » $= +3^0$, and adding
Urbanite . . . . » $= +16^0$,

the near agreement with acmite also in this respect becomes obvious.

The sections show the mineral to be strongly pleochroitic, with the following axial colours

$\mathfrak{a}$ = brown
$\mathfrak{b}$ = yellow brown
$\mathfrak{c}$ = light yellow,

Before the blow-pipe the mineral fuses with some difficulty to a translucent magnetic globule; in the closed tube gives off very little water; it is only partially decomposed by acids. Tests in the wet way proved the iron of the mineral to be present chiefly as a sesquioxide. And the qualitative examination showed the presence of a large amount of Na.

The optical properties of the mineral as well as the result of the qualitative test having made it evident that the mineral is not a schefferite, a quantitative examination of it was resolved upon, which was performed by mr R. MAUZELIUS.

For the main analysis were used . . . . . . 0.5675 gr.
» » determination of alkalies were used 0.6976 »
» » » » FeO » » 0.4696 »

The material for the two latter determinations was taken from another specimen than that used in the main analysis, which circumstance probably accounts for the excess of 1.36 % given by the analysis.

Analysis XXI. (R. Mauzelius.)
Urbanite from Långban.
Gravity 3.52 at + 17° C.

	%.	Molecular ratio.		
SiO_2	51.61	0.854	0.854	5
Al_2O_3	0.74	0.007	0.177	1.03
Fe_2O_3	27.24	0.170		
FeO	0.54	0.007	0.187	1.09
MnO	1.73	0.024		
CaO	4.90	0.088		
MgO	2.75	0.068		
K_2O	0.36	0.004	0.175	1.02
Na_2O	10.59	0.171		
Loss on ignition	0.90	0.050		
	101.36	—	—	—

How the loss on ignition is to be explained, must be left undecided. As it arises from the mineral being but slightly ignited and does not increase on stronger ignition, it is probably water. From want of material for analysis I have not been able to determine the water directly. In interpreting the analysis I, therefore, consider it most proper not to take any water into account. What is most striking in the analysis, is the high percentage of sesquioxide of iron — 27.24 % —, while only a very slight amount of protoxide of iron is present. Also the percentage of manganese protoxide is rather small. By this, and also by the high percentage of alkalies, the mineral differs considerably from schefferite.

As is seen from the figures indicating the molecular ratio, the analysis leads to the metasilicate formula; for if the water is neglected and $\overset{III}{R}_2O_3$ is changed to 3RO, the ratio is

$$RO : SiO_2 = 1.04 : 1.$$

The different constituents are present in the following proportions:

$$\begin{array}{ccccccc} SiO_2 & : & Fe_2O_3 & : & (Ca, Mg)O & : & Na_2O \\ 5 & : & 1.03 & : & 1.09 & : & 1.02 \end{array}$$

which evidently gives the formula

$$(Ca, Mg)O . SiO_2 + Na_2O . Fe_2O_3 . 4SiO_2,$$

the former member of which is the common diopside silicate, the latter the acmite silicate, each of which is represented by one molecule.

If the water is taken into account and regarded as combined with one of the metals, for instance in the form HO — Fe = or the like, the following ratio is obtained:

$$RO : Si\,O_2 = 0.99 : 1,$$

and the formula is not essentially changed.

The peculiar composition shown by this analysis distinguishes the mineral decidedly from the schefferite and affords an explanation of its optical and crystallographical relation to acmite, pointed out above. It also distinguishes the mineral from all the other members of the pyroxene group and entitles it to an independent place in this group.

Though this mineral has not until now been defined and separated from allied minerals nor its place in the system known, yet it has long ago been the subject of investigation, though it was then confounded with schefferite.

It is well known that the schefferite was discovered by MICHAELSON, who in 1862 published an investigation of it[1].

The mineral examined by MICHAELSON was of a reddish brown colour and a specific gravity of 3.39, gave a metasilicate formula, and could in all reason be regarded as a variety of augite with about 10 % manganese protoxide; its percentage of iron was insignificant: 1.63 % ferrous oxide and 3.97 % ferric oxide. MICHAELSON himself considers all of the iron to have originally been present in the protoxide state and calculates the formula on this assumption.

Later[2] BREITHAUPT published an analysis and description of a mineral from the Långban mine, which he hesitatingly identifies with the schefferite of MICHAELSON. The analysis made by WINKLER differs from that of MICHAELSON by giving the whole of the iron percentage as ferric oxide. The percentage of ferric oxide amounts to 25.43 %.

BREITHAUPT himself expresses some doubt as to the identity of the minerals on which the two analyses had been made. Induced, however, by the outward resemblance of the minerals and the agreement as to their paragenesis, he feels inclined to assume their identity. BREITHAUPT mentions that he had intended to propose the name Wallerian for the new mineral, but, on MICHAELSON's publication appearing before his own, gave it up[3].

Since that time the schefferite described by BREITHAUPT and analyzed by WINKLER has fallen into oblivion, or the analysis has been regarded as erroneous.

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[1] K. Vet. Ak. Öfvers. 1862, p. 506.

[2] Berg u. Hüttenm. Zeitung 1865, p. 429.

[3] BREITHAUPT erroneously quotes IGELSTRÖM instead of MICHAELSON and ascribes the analysis as well as the name schefferite to IGELSTRÖM.

DANA, who in the 5:th edition of his »A system» (1868) mentions two minerals under the name of schefferite, *viz.* that of MICHAELSON and that of BREITHAUPT, places, however, the latter among the amphiboles on account of the prismatic angle of 120° 45′ given by BREITHAUPT. He also quotes the analysis of WINKLER, adding: »It requires further study.» In the 6:th edition of DANA's work (1892), as well as in the Manual of HINTZE, no mention is made of the schefferite analyzed by WINKLER.

It is evident that the schefferites of MICHAELSON and BREITHAUPT are two distinct species, and that the schefferite of the latter, which was analyzed by WINKLER, is identical with the mineral described in the above lines. This appears from the following table, in which the analyses are arranged together, and which also comprises the so-called iron schefferite from Långban and Pajsberg.

	Schefferite		Iron Schefferite		Urbanite	
	Långban Michaelson	Långban Flink	Långban Flink	Pajsberg Flink	Långban Breithaupt	Långban Sjögren
SiO_2	52.31	52.28	52.19	50.88	49.500	51.61
Al_2O_3	—	—	0.88	1.97	1.425	0.74
Fe_2O_3	3.97	—	—	—	25.430	27.24
FeO	1.63	3.83	14.98	17.48	—	0.54
NiO	—	—	—	—	0.204	—
MnO	10.46	8.39	6.20	6.67	6.777	1.73
MgO	10.86	15.17	10.93	9.08	4.267	2.75
CaO	19.09	19.62	14.57	12.73	7.752	4.90
K_2O	—	—	—	—	0.193	0.36
Na_2O	—	—	—	—	—	10.59
Loss on ignition . .	0.60	—	—	—	—	0.90
Total	98.92	99.29	99.75	98.81	95.548[1]	101.36

There needs only a glance at this table to satisfy one's self that the minerals analyzed are two distinct species, *viz.* the true schefferite (that of MICHAELSON) with its variety, the iron schefferite, and the mineral here named urbanite, which differs from the schefferite by the large percentage of sesquioxide of iron and alkalies present. The latter mineral BREITHAUPT has had in hand, though he erroneously unites it to schefferite. WINKLER's analysis is correct in the main, except that he seems to have overseen the presence of Na[2].

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[1] The analysis also shows 3.08 % $CaCO_3$ and 0.02 % $MnCO_3$ owing to impurities.

[2] I should have liked to revive the name Wallerian, given by BREITHAUPT to this mineral. However, as he has used the same name for a black amphibole from Nordmark, which he regarded as triclinic, I have thought that the application of the name also to a pyroxene would cause confusion and have on this ground preferred a new name.

2. Urbanite from the Glakärn mine, province of Örebro.

At the beginning of 1892 some material of this mineral was handed to me for examination by mr L. J. IGELSTRÖM, who had already made a preliminary analysis of it. The analysis that I afterwards caused to be made, as well as the optical investigation, showed the mineral to be identical with the urbanite from Långban just described.

At first a few words may be said about the locality and mode of occurrence of the mineral. The Glakärn mine is an old, but very inconsiderable mine situated in the parish of Linde, province of Örebro. The following statements have been given by IGELSTRÖM[1]. The chief ores of the mine are jacobsite and braunite, the former predominating, sometimes occurring as pure veins and nodules a centimeter in size and, besides, disseminated as close grains in the vein-mass, which consists chiefly of manganese silicates, manganese garnet, rhodonite, and calcite. The thickness of the whole ore-deposit is several metres, its length about 50 m. Neither hausmannite nor magnetite seems to be present. IGELSTRÖM calls attention to the singular fact that in this place the manganese minerals do not, as in all other Swedish manganese mines, lie in limestone, but directly in hälleflinta.

The urbanite occurs as idiomorphic grains imbedded in a mixture of rhodonite and a whitish yellow variety of feldspar, which mixture forms veins of a few centimetres in thickness in the jacobsite and braunite of which the ore consists.

By reflected light the urbanite has a characteristical, chestnut-brown colour; it is faintly translucent, shows two distinct cleavages, making nearly right angles with each other and corresponding to the cleavages of pyroxene, and one less distinct, oblique to the others. Its hardness is about 6. The streak is light brown. Its external characters are such as to make it easily confounded with schefferite.

The grains always occur imbedded and of a size of 0.5—1.5 cm. No crystals have been observable. The only crystallographical determination possible has been the measurement of the prismatic angle of cleavage. This angle, too, is difficult to determine exactly, because the cleavage planes often are curved and give bad images of reflection. The results of the measurements vary between 95° and 97°; as a mean I have found 96° 30′.

With regard to its optical properties the mineral is found to be monoclinic. Sections parallel to the orthodiagonal show symmetrical extinction; sections parallel to the plane of symmetry, on the other hand, present a deviation of 22° between the extinction-direction and the *c*-axis; as the basic cleavage is visible on the section, one can satisfy one's self that this extinction-direction falls within the obtuse axial angle, and further

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[1] Geol. Fören. Förh. Vol. 12, p. 137.

investigation shows that this direction corresponds to the axis of the greatest optical elasticity $\mathfrak{a}$. The optical orientation is consequently defined by the angle

$$\mathfrak{a} \wedge c = +22^{\circ}.$$

Here we call attention to the fact that in the urbanite from Långban the corresponding angle is + 16°.

Also the urbanite from Glakärn is strongly pleochroitic. The axial colours are

$\mathfrak{a}$ = bronze-brown
$\mathfrak{b}$ = brownish yellow
$\mathfrak{c}$ = sulphur-yellow.

Before the blowpipe the mineral from Glakärn behaves like the above described urbanite from Långban. It fuses with difficulty to a magnetic globule and gives reactions for iron and manganese. It is but slightly attacked by hydrochloric acid. A qualitative examination shows the iron to be present chiefly as a sesquioxide. A quantitative analysis has given the following results.

Analysis XXII. (R. Mauzelius.)
Urbanite from Glakärn.
Gravity 3.53 at + 16° C.

	%.	Molecular ratio.	
SiO_2	49.21	0.815	0.816
TiO_2	0.06	0.001	
Al_2O_3	1.27	0.012	0.170
Fe_2O_3	25.35	0.158	
FeO	0.50	0.007	0.386
MnO	6.71	0.095	
CaO	5.68	0.101	
MgO	1.39	0.035	
Na_2O	8.95	0.144	
K_2O	0.40	0.004	
H_2O	1.05	0.058	0.063
Fl_2	0.20	0.005	
	100.77	—	—
O equal to Fl_2	0.08	—	—
Total	100.69	—	—

In the analysis were used 0.6124 gr. for the determination of H_2O, SiO_2, Fl. etc.
» » » » 0.6062 » » » » alkalies
» » » » 0.5182 » » » » FeO
» » » » 0.2542 » for a duplicate test for SiO_2.

Besides this a determination of fluorine was made on material derived from another specimen and which was not perhaps so pure as the rest. 0.6010 gr. then gave 0.96 % Fl.

Supposing $3\overset{II}{R}O$ to be replaced by equivalent amounts of $\overset{III}{R}_2O_3$, supposing also H_2O and Fl_2 to be combined with the metals and to lower their value of saturation, we obtain a metasilicate formula:

$$SiO_2 : \overset{II}{R}O = 0.879 : 0.896 = 1 : 1.02.$$

If the formula is written analogous to that of the urbanite from Långban, we obtain:

$$\begin{aligned} \overset{II}{R}O : \overset{III}{R}_2O_3 : SiO_2 &= 0.386 : 0.170 : 0.879 \\ &= 2.19 \;\; : 0.97 \;\; : 5 \end{aligned}$$

and consequently

$$2(Ca,\ Mn,\ Mg,\ Na_2)O \cdot Fe_2O_3 \cdot 5SiO_2,$$

which may also here be separated into

$$(Ca,\ Mn)O \cdot SiO_2 + Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$$

i. e. one molecule of rhodonite silicate, and one molecule of acmite silicate, with the alkalies partially replaced by Ca.

Thus, there is a manifest agreement between the two minerals from Glakärn and Långban with regard to their composition.

Summary of the foregoing and characterization of the new mineral urbanite. The mineral here described has heretofore been confounded with schefferite, with which it bears a close external resemblance. It is probably identical with the mineral long ago examined by BREITHAUPT and analyzed by WINKLER. It is monoclinic with the axial ratio agreeing with that of the pyroxene group: $a : b : c = 1.1009 : 1 : 0.6058$, $\beta = 72° 7'$. The forms $a(100)$, $b(010)$, $m(110)$, $u(111)$, $s(11\bar{1})$, $r(053)$ are the most important; besides these there are several others. Cleavages prismatic (110), distinct; basal cleavages less distinct. H = 6. Gravity = 3.52—3.53. Lustre vitreous, colour brownish black (Långban) to chestnut-brown (Glakärn). Streak light brown. Faintly translucent; strongly pleochroitic. Optic axes lying in the plane of symmetry; the axis $\mathfrak{a}$ makes with the crystallographic c-axis an angle of + 16° (Långban) to + 22° (Glakärn), which comes nearest to the optical orientation of acmite. In composition it is a metasilicate nearly corresponding to $(Ca,\ Mn,\ Mg)O \cdot Na_2O \cdot Fe_2O_3 \cdot 5SiO_2$, which is equal to a molecule of diopside or rhodonite silicate and one of acmite silicate. Before the blowpipe it fuses with difficulty to a magnetic, faintly translucent slag. Not decomposed by acids. Found beautifully crystallized in drusy cavitiesin finely granular hematite at Långban and as idiomorphic grains in a mixture of yellowish white feldspar and rhodonite in the Glakärn mine, province of Örebro. The mineral probably also occurs in other swedish manganese mines, though it has hitherto been confounded with schefferite.

16. On the Composition and Crystalline Form of Caryinite from Långban.

The caryinite was first described in 1874[1] by C. H. LUNDSTRÖM, who on the ground of his analysis proposed for the mineral the formula $3\,RO\,.\,As_2O_5$ (R chiefly Ca, Mn, Pb), *i. e.* the formula of a normal ortho-arseniate. LUNDSTRÖM describes the mineral as being in colour brown to yellowish brown in various shades, having a greasy lustre, and a specific gravity of 4.25. The material that LUNDSTRÖM had at his disposal had no cleavages and was mixed with calcite and hausmannite. The analysis showed an amount of 3.86 p. c. of CO_2, which was supposed to be due to the admixture of calcite.

For the sake of comparison with the new analysis of the mineral given below, we quote the original analysis made by LUNDSTRÖM.

Analysis of Caryinite by C. H. LUNDSTRÖM.

Sp. gr. = 4.25.

PbO	10.52
MnO	15.82
FeO	0.54
CaO	16.40
MgO	4.25
CO_2	3.86
As_2O_5	47.17
Cl	0.07
Insol.	0.65
Total	99.28

Shortly after, A. SJÖGREN published the result of a microscopic investigation of this mineral[2], which in an interesting manner supplements the chemical examination made by LUNDSTRÖM. This investigation shows that the material analyzed by LUNDSTRÖM was not a homogeneous mine-

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[1] Geol. Fören. Förh. Vol. 2, p. 178, p. 223.

[2] Geol. Fören. Förh. Vol. 2, p. 533.

ral, but a mixture of berzeliite, caryinite and calcite (or dolomite)[1]. The two first-mentioned minerals differ immediately in their optical properties. The berzeliite is isotropic[2], colourless by transmitted light, and shows irregular cracks or indistinct cleavages. The caryinite is anisotrope, of a light yellow colour, and has at least two distinct cleavages, one of which is more distinct than the other, and which cut each other at right angles. The two minerals occur together in such a mode that the berzeliite forms zones of lighter colour enclosing the caryinite. It is true that berzeliite may be found alone in the granular calcite without being associated with caryinite, but A. SJÖGREN never found caryinite that was not enclosed by berzeliite. This peculiar mode of occurrence makes A. SJÖGREN express the opinion that berzeliite is an alteration product of caryinite. And as the minerals have the same formula $3 \, R \, O \, . \, As_2 \, O_5$, in which in the caryinite R consists of Pb, Mn, Ca, and Mg, and in the berzeliite of Ca, Mg, and Mn, the alteration of caryinite into berzeliite implies, according to the said author, that Pb and Mn are dissolved out and replaced by Ca and Mg.

W. LINDGREN[3] has published further observations, which confirm those of A. SJÖGREN. He found specimens of caryinite of the kind first described consisting of almost equal amounts of berzeliite, calcite, and caryinite. That berzeliite really is a product of alteration of caryinite, LINDGREN found evident from the character of some specimens differing in appearance from the finely granular caryinite first described. They present veins of 0.03 to 0.04 m. consisting of light amphibole, calcite, and brown caryinite traversing massive braunite. Where the vein widens, the caryinite passes into honey-yellow berzeliite; at the transition the caryinite is very dull in colour and highly decomposed, shows turbid polarization colours and encloses here and there small grains of clear berzeliite. LINDGREN is of opinion that this fact can be accounted for only by presuming the berzeliite to have arisen from the alteration of the caryinite. As regards the characters of the caryinite in other respects, LINDGREN states that in thin sections between crossed Nicols it shows vivid red, green, and yellow interference colours; dichroism is not observable. Three cleavages at nearly right angles to one another have been observed. From this LINDGREN infers that the mineral probably belongs to the orthorhombic system.

In 1881 DES CLOIZEAUX made a closer optical investigation of the caryinite from Långban[4]. The cleavage pieces examined by DES CLOIZEAUX showed two cleavages at an angle of 50° (130°). DES CLOIZEAUX

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[1] That the mineral examined microscopically by A. SJÖGREN was quite identical with that already analyzed by LUNDSTRÖM, is not stated by SJÖGREN in his article, but has been verbally communicated by him to the author.

[2] Through this investigation by A. SJÖGREN the isotropic character of the berzeliite and its belonging to the regular system were established for the first time.

[3] Geol. Fören. Förh. Vol. 5, p. 556.

[4] Bull. Soc. Min. de France. Vol IV, p. 56.

thought that these cleavages corresponded to *p* and *h'* in a monoclinic mineral [= (001) and (100)], in which, as will be seen below, he was wrong. Thin sections parallel to one of these cleavages were found to be nearly at right angles to a positive optic bisectrix. The optic axial angle was measured in air $2E = 41^\circ 58' - 47^\circ$. Weak dispersion of optic axes $\varrho > v$; dispersion of middle line horizontal, which makes DES CLOIZEAUX conclude that the mineral belongs to the monoclinic system. These statements are also found in the »Manuel de Minèralogie» by DES CLOIZEAUX[1] as well as in DANA's »A System» and other Manuals and Textbooks of Mineralogy of greater compass.

In later years specimens of caryinite differing in appearance from the original find have been met with at Långban. I have obtained such specimens from mr H. V. TIBERG, manager of the mines; and in the collection of the late mr A. SJÖGREN, I found several. Thus having a comparatively rich material at my disposal, I resolved to undertake a renewed investigation of this interesting mineral, the existing descriptions of which are not only incomplete, but also at variance with one another.

The material of the new kind occurs filling fissures in a coarsely crystalline mixture of schefferite, rhodonite, and hedyphane. The material that fills the fissure also contains hedyphane in the border portions and caryinite in the middle. The caryinite has the same characteristical colour as that described by LUNDSTRÖM, but differs from it by not being finegrained, but massive with distinct cleavages. In sections it is found to be homogeneous, doubly refracting without dichroism. Along the cleavages one often finds narrow veins of a colourless, isotropic mineral, apparently berzeliite. The latter is interlarded with darker interpositions, which are never found in the caryinite. The occurrence of berzeliite along the crevices in the caryinite is another proof that in this case the berzeliite owes its origin to the alteration of the caryinite. This is still more obvious in some sections where the alteration has spread from the crevices into the mass of the caryinite.

In thin sections, as well as macroscopically, three distinct cleavages *d, b, d'* are observable. On a fragment the angles between these cleavages were measured:

$$d : b = 49^\circ 10'$$
$$b : d' = 49^\circ 20'.$$

Hence it is evident that the faces *d* and *d'* are equivalent and that the angle between them is bisected by *b*; *d* and *d'* may then be taken as prismatic faces $\infty P\,(110)$, and *b* then becomes the brachydiagonal pinacoid with the sign $(010)\ \infty \check{P} \infty$. It is further highly probable that to the angles of 49° 10' and 49° 20', or of 49° 15' as a mean, corresponds the angle of about 50° given by DES CLOIZEAUX, though he found only one such angle.

A plate at right angles to the zone *bd* shows extinction parallel and at right angles to *b*, which confirms that *b* is a plane of symmetry.

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[1] Tome II, p. 409; 1893.

This plate shows an axial figure and an optic bisectrix that seems to stand vertically to the plate; hence the mineral ought to be orthorhombic.

Another plate parallel to *b* likewise shows symmetrical extinction and axial figure; this confirms that the mineral is orthorhombic. The optic bisectrix, which also here stands at right angles to the plate, is evidently the acute one, because the distance between the poles of the axial figure is less than in the other plate. The axial angle is not measurable, since plates of sufficient thickness were highly cracked and dull. The acute bisectrix is positive. Dispersion of optic axes $\varrho > v$. The horizontal dispersion mentioned by DES CLOIZEAUX could not be observed.

By these determinations the optic orientation is established. The plane of the optic axes is parallel to the macrodiagonal pinacoid (100), the acute bisectrix, which is positive, coincides with the macrodiagonal *b,* and the obtuse bisectrix with the vertical axis *c*.

As only one analysis of the caryinite had hitherto been made, namely the original analysis of LUNDSTRÖM, and as, besides, the material used for that analysis was not homogeneous, but consisted of a mixture of caryinite, berzeliite, and calcite, it was thought necessary to analyze the pure caryinite described above. The analysis was made on perfectly pure and undecomposed material, whose homogeneity and freshness had been tested microscopically.

Analysis XXIII. (R. Mauzelius.)

Caryinite from Långban.

Spec. gr. 4.29 at $+ 14_0$ C.

	%	Molecular ratio	
As_2O_5	49.78	0.216	0.217
P_2O_5	0.19	0.001	
V_2O_5	trace?	—	
PbO	9.21	0.041	0.698
FeO	0.54	0.007	
MnO	18.66	0.263	
MgO	3.09	0.077	
BaO	1.03	0.007	
CaO	12.12	0.216	
K_2O	0.37	0.004	
Na_2O	5.16	0.083	
H_2O	0.53	0.030	0.030
Cl	trace		
Total	100.68		

For the analysis were used 0.5634 gr. dried at 110° C. Whether the small percentage of iron is present in the protoxide state or as a sesquioxide, was not tested; it has been assumed to be present as a protoxide like the other substances. The percentage of water was determined directly. Fluorine was searched for, but found to be absent.

On account of the freshness of the material analyzed the slight percentage of water must be regarded as belonging to the formula of the mineral. In proposing the formula two eventualities must be taken into consideration, depending on the position assigned to the water.

If the water is assumed to be combined with the negative radicals, the ratio obtained is

$$R\,O : As_2\,O_5 = 0.728 : 0.217 = 10.06 : 3,$$

and the formula deduced is

$$R_{10}\,As_6\,O_{25} = 10\,R\,O\,.\,3\,As_2\,O_5.$$

If, on the other hand, $H_2\,O$ is supposed to be combined with the bases and to lower their value of saturation, in which case the group $H\,O - \overset{II}{R} -$ is present, the ratio is as follows:

$$\left\{\begin{matrix} \overset{II}{R}\,O \\ (H\,O - \overset{II}{R})_2\,O \end{matrix}\right\} : As_2\,O_5 = 0.668 : 0.217 = 3.08 : 1,$$

and the formula then is

$$\overset{II}{R}_3\,As_2\,O_8 = 3\,R\,O\,.\,As_2\,O_5,$$

in which $\overset{II}{R}$ is in part replaced by $2\,(H\,O - \overset{II}{R})$; that is the formula of a somewhat basic ortho-arseniate. To which of these formulæ the preference should be given cannot be told. The analysis agrees equally well with both interpretations and admits of both.

As to the analysis of LUNDSTRÖM, it agrees in the main with that of MAUZELIUS; the only difference of importance is, that the analysis of LUNDSTRÖM shows no alkalies, which may depend on a different composition of the variety analyzed by him. If an amount of Ca O, corresponding to $C\,O_2$, 8.77 p. c. in all, and 0.65 p. c. insoluble are deducted, and the remainder is calculated to 100, the agreement becomes manifest. The analysis then presents the following appearance:

	%	Molecular	ratio
$As_2\,O_5$	52.49		0.228
Pb O	11.70	0.052	0.654
Fe O	0.60	0.008	
Mn O	17.61	0.248	
Mg O	4.72	0.117	
Ca O	12.80	0.229	
Cl_2	0.08	0.001	

Also this analysis corresponds pretty well, though not quite so well as the new one, to the formula of the orthoarseniate.

Summary. The later finds of caryinite at Långban differ from the original finds by the occurrence of the mineral in a pure state and in larger masses admitting of chrystallographical and optical examination, whereas the caryinite originally analyzed was a mixture of caryinite, berzeliite and calcite. — The caryinite belongs to the orthorhombic system, but has not as yet been found as crystals. The following determinations may be made, supplementing and in part correcting the statements of DES CLOIZEAUX: $a : b : c = 0.86165 : 1 : ?$ Cleavages distinct along ∞P (110) and $\infty \check{P} \infty$ (010). The optic axial plane parallel to $\infty \bar{P} \infty$ (100); the acute bisectrix, which is positive, coincides with the macrodiagonal b, and the obtuse bisectrix with the vertical axis c. The optic axial angle $2E = 41^\circ 50' - 47^\circ$ (DES CLOIZEAUX). Dispersion of optic axes $\varrho > v$. Not pleochroitic. Subtranslucent. Lustre greasy. Colour nutbrown. Hardness 4. Spec. gr. = 4.25 (LUNDSTRÖM) to 4.29 (MAUZELIUS). The new analysis shows the presence of more than 5 p. c. of soda and leads to one of the formulæ $R_{10} As_6 O_{25}$ or $R_3 As_2 O_8$, according as the water present is assumed to be combined with the acids or the bases.

17. On Soda Berzeliite from Långban.

Pl. IV. Figs. 8, 9.

Several times in the course of the last years a berzeliite-like mineral has been met with at the Långban mines, the peculiar appearance of which called for an investigation of its nature. It is orange-yellow to fire-red in colour, has a waxy lustre, fracture conchoidal to uneven, and no distinct cleavage. In most cases it is massive; occasionally it has been found in a crystallized state. Hardness 4 to 4.5. Spec. gr. = 4.21.

In the specimens at my disposal the mineral occurs as veins or nodules in a finely crystalline, magnesian limestone. It seems to be frequently associated with a very fine scaly, darkbrown, probably manganiferous mica, which has not as yet been subjected to examination. Sometimes it also occurs with a greyish violet, amorphous, unknown mineral, that bears some resemblance to amphodelite.

When occurring crystallized, the mineral presents the same forms previously observed on berzeliite. As is well known, berzeliite crystals are very rare, having been met with only at Långban. Such crystals have been described by FLINK[1] who established the existence not only of the dominant form (112), but also of the subordinate forms (110), (100), and (210). The majority of the crystals examined by mr FLINK were developed with rounded edges and rounded solid angles; only few of them showed brilliant faces and sharp angles.

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[1] Bih. Kongl. Vet. Akad. Handl. Vol. 12, Sect. 2, p. 33, 1886.

The material available to me was found to agree chrystallographically with the common berzeliite as desrcibed by FLINK. Some of the crystals consisted only of the icositetrahedron (211), Pl. IV, fig. 8; others presented a combination of this form and the rhombic dodecahedron (110), with the former dominant, Pl. IV, fig. 9. Under the microscope the mineral was found to be perfectly isotropic with honey-yellow colour.

Though the mineral does not differ in chrytallographical development from the berzeliite, the only external difference being its deep yellow colour, yet I resolved to have an analysis of it made in connection with the analyses of berzeliite minerals and other arsenates from the Wermlandian mines which I have caused to be made during the last years. Notwithstanding the pretty numerous analyses of berzeliite already made, the formula of this mineral cannot be said to have been definitively established, since as many analyses lead to the normal orthosilicate formula $3\,RO\,.\,As_2O_8$ as to the discrepant formula $10\,RO\,.\,3\,As_2O_5$. Nor has any one considered the small percentage of chemically combined water constantly present, which cannot, however, be wholly neglected in establishing the formula.

A particular reason for giving this analysis in this very place is its deviating considerably from the common berzeliite in one respect, namely in its percentage of Na_2O, besides which its composition agrees in a surprising manner with that of the caryinite described in the preceding No. of these papers.

The analysis was made on carefully selected material, which had been found under the microscope to be homogeneous and undecomposed.

Analysis XXIV. (R. Mauzelius.)
Soda berzeliite from Långban.
Sp. gr. = 4.21 at + 17° C.

	%	Molecular ratio	
As_2O_5*	52.90	0.230	0.231
Sb_2O_5	trace	—	
V_2O_5	0.24	0.001	
Cl	trace	—	
FeO	0.38	0.005	0.734
MnO*	21.41	0.302	
CaO*	18.34	0.327	
MgO*	0.72	0.018	
K_2O	0.09	0.001	
Na_2O	5.05	0.081	
H_2O	0.40	0.022	0.022
Total	99.53		

The analysis was carried out in two parts on material from the same specimen. In the first part of the analysis all of the constituents except the alkalies were determined; for this were used 0.8279 gr., which gave 0.0036 gr. insoluble = 0.43 %. For the determination of the alkalies mere used 0.8941 gr., which gave 0.0048 gr. insol. = 0.54 %. At the same time duplicate determinations of some of the ingredients were made. The values marked in the analysis with an asterisk are means of two determinations. The water was determined directly by weighing. In calculating the analysis the insoluble quantities were deducted.

In interpreting this analysis the view held with regard to the part played by the water is of decisive importance, as was also the case with respect to several of the previous analyses. If the water is considered to be present as a base, *i. e.* combined with the negative constituents, we obtain the following ratio:

$$\overset{\text{II}}{R}O : As_2O_5 = 0.756 : 0.231 = 10 : 3.05,$$

and the formula then is

$$R_{10}As_6O_{25} = 10\,RO \,.\, 3\,As_2O_5.$$

Assuming, on the other hand, H_2O to be combined with the bases and to lower their value of saturation (as the group $HO - \overset{\text{II}}{R} -$), we obtain the ratio

$$\overset{\text{II}}{R}O : As_2O_5 = 0.712 : 0.231 = 3.08 : 1,$$

which evidently leads to the formula

$$\overset{\text{II}}{R}_3As_2O_8 = 3\,RO \,.\, As_2O_5.$$

Hence the composition would be that of a somewhat basic arseniate.

The close agreement of the composition with the formulae proposed for the caryinite in the preceding No. of these papers is striking. In both cases the formula obtained depends wholly on the view held with regard to the water present. If the water is placed among the bases, *i. e.* regarded as combined with the negative radicals, we obtain in both cases the formula

$$10\,RO \,.\, 3\,As_2O_5.$$

If, on the other hand, we consider the water as combined with the bases, the formula obtained is that of the ortho-arseniate:

$$3\,RO \,.\, As_2O_5.$$

The agreement in composition becomes as manifest on comparing the two analyses directly. In both minerals MnO and CaO are the most important positive constituents; both minerals contain about 5 p. c. of NaO, the presence of which in caryinite as well as in a mineral of the berzeliite group is shown for the first time. The only difference of some consequence is that the caryinite contains about 9 p. c. of PbO, which base is absent from the berzeliite mineral.

The circumstance that the minerals, notwithstanding their analogous composition, crystallize in different systems, the caryinite being orthorhombic, the soda berzeliite isometric, may he due to one of the following causes:

1) Either the minerals differ in composition, one of them having the formula $3 RO . As_2 O_5$, the other $10 RO . 3 As_2 O_5$; or

2) the minerals have the same composition, but are dimorphous; or

3) it is the amount of lead present in the caryinite, that, while the chemical constitution is the same in other respects, causes the difference with regard to the crystal system.

Both the analysis and the formula show that the mineral must be reckoned among the berzeliites. However, its composition presents a few peculiarities, owing to which it must be regarded as a characteristical variety among these minerals. Among these peculiarities I attach but little importance to the slight percentage of $V_2 O_5$ — though it is interesting enough, as Vanadium minerals have not as yet been met with at the Långban mine —, but I lay the greater stress on the 5 p. c. (or nearly so) of alkalies present. FLINK has, it is true, found 0.73 % of Na O in a berzeliite from Långban[1], but so large quantities of Na O as the analysis shows, have hitherto been unknown in any mineral of the berzeliite group. I have, therefore, thought the name Soda Berzeliite well justified.

IGELSTRÖM's pyrrho-arsenite from the Sjögrufva, which also evidently is only a variety of berzeliite, seems to be very near the soda berzeliite in some respects. There is an agreement with regard to the deep yellowish red to fiery red colour as well as to the high precentage of manganese, which in both minerals is higher than in the normal berzeliite. As, however, the pyrrho-arsenite has been defined as an antimonial berzeliite, the mineral here described cannot be united to it, since it contains only traces of $Sb_2 O_5$; moreover, the considerable amount of alkalies which it contains distinguishes it from pyrrho-arsenite.

Summary. A mineral of berzeliite-like appearance attracted attention through its fire-red to orange-yellow colour. It occurs mostly massive, sometimes crystallized in the forms (211), (110), the former of which is always dominant, sometimes the only one. Cleavage wanting. $H = 4—4.5$. Sp. gr. = 4.21. Lustre greasy; isotropic. The analysis leads to either of the formulae $R_{10} As_6 O_{25}$ or $R_3 As_2 O_8$, according as the water present is considered as combined with the negative or the positive radicals. Because of an amount of about 5 % of Na O, which is absent from other berzeliite minerals, I propose the name Soda Berzeliite as a designation for this variety. The mineral is very near in composition to the caryinite, except that the latter contains lead.

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[1] Bih. t. Kongl. Sv. Vet. Ak. Handl. Vol. 12, Sect. 2, p. 31, 1886.

18. Långbanite from the Sjögrufva.

Långbanite has hitherto been known only from the Långban mines, the locality, where it was originally found[1]. As regards the particulars connected with its discovery at that locality and as for its chemical and chrystallographical properties I refer the reader to my article No. 6 in these Contributions[2]. It is an interesting fact that this peculiar mineral has now been found also at another mine, the Sjögrufva in the province of Örebro.

In May 1893 I obtained from mr IGELSTRÖM a few specimens of a mineral from this mine, which he designated as »a new, probably orthorhombic stibiate from the Sjögrufva». Mr IGELSTRÖM had made a preliminary analysis of the mineral, which gave him

Sb_2O_5	16.00 %	
MnO	66.00 »	
FeO	14.00 »	
H_2O	2.56 »	(probably loss on ignition.)
	98.56 %	

The mineral occurs in a mixture of rhodonite, manganophyllite, braunite, and finely granular calcite, forming seams of about 0.01 m. in thickness. Sometimes when it occurs in idiomorphously developed individuals, traces of hexagonal outlines are observable. One distinct cleavage is at right angles to the hexagonal boundaries. The mineral is black, with a metallic lustre resembling that of hematite. Hardness 6.5; streak brownish red; in thinnest splinters subtranslucent, with red colour.

The mineral generally forms lamellar masses; however, it is probable that it also occurs in another variety as finely granular to compact masses. This variety has not been subjected to examination; it has only been ascertained that it contains antimony. Sometimes, however, the two varieties seem to graduate into each other. Yet it is possible that the finely granular variety is nothing but braunite with the admixture of some amount of Långbanite or some other of the antimonial minerals described by IGELSTRÖM as occurring at the Sjögrufva.

On account of the agreement in external resemblance with Långbanite I foundit not unlikely that the specimens I had received contained this mineral; to this assumption I was also induced by the preliminary analysis of IGELSTRÖM. And it has been fully confirmed by the complete and careful analysis made by MAUZELIUS. The material available for the analysis did

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[1] Already in the year 1888 mr IGELSTRÖM suggested the occurrence of Långbanite at the Sjögrufva, but having only a single poor specimen at his disposal he could not make any chemical or physical investigations, but only judge from external characters. This find may thus be said to be highly doubtful. Geol. Fören. Förh. Vol. X, p. 417, 1888.

[2] Bull. of the Geol. Instit. of Upsala, Vol. I, p. 41, 1892; Contrib. to Swedish Mineralogy, Part. I, p. 41.

not perhaps answer the very greatest claims on purity, but may be said to have been tolerably satisfactory. The analysis was performed in the same manner as the previously described analysis of Långbanite from Långban[1]. The quantity of oxygen set free at the decomposition was determined by the method of BUNSEN; the slight amount of water was weighed.

For the main analysis were used 0.4992 gr., for the determination of the oxygen 0.0965 gr.

Analysis XXV. (R. Mauzelius.)

Långbanite from the Sjögrufva.

Sp. gr. = 4.60 at + 19° C.

	%	Molecular ratio		
Sb_2O_3	12.51		0.043	0.087
Fe_2O_3	13.98		0.087	0.177
SiO_2	12.82	0.212	0.492	1.000
MnO_2	24.36	0.280		
MnO	32.22	0.454	0.525	1.070
CaO	2.40	0.043		
MgO	1.11	0.028		
H_2O	0.52	0.029		
	99.92			
O	3.09			

The analysis consequently leads to the following ratio of the components:

$$Sb_2O_3 : Fe_2O_3 : RO_2 : RO = 0.087 : 0.177 : 1 : 1.07.$$

Here, too, as in the analyses of Långbanite from Långban, we find a simple ratio of $\overset{IV}{R}O_2$ to $\overset{II}{R}O$, namely very close to 1 : 1.

These two components may, therefore, be brought together as one, $\overset{II}{R}O . \overset{IV}{R}O_2$, or $\overset{III}{R}_2O_3$, built up like the two others Fe_2O_3 and Sb_2O_3. Hence, the Långbanite from the Sjögrufva might, like the same mineral from Långban, be regarded as an isomorphous mixture of the constituents Sb_2O_3, Fe_2O_3, and $\overset{II}{R}\overset{IV}{R}O_3$ ($\overset{II}{R}$ = Mn, Ca, Mg; $\overset{IV}{R}$ = Mn, Si) and its formula be written accordingly:

$$m\, Sb_2O_3 + n\, Fe_2O_3 + p\, \overset{II}{R}\overset{IV}{R}O_3,$$

where $m : n : p = 87 : 177 : 1000 = 10 : 20 : 115$.

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[1] Bull. of Geol. Inst. Vol. 1, p. 42; Contributions etc. Part. I, p. 42.

The agreement in composition with the Långbanite from Långban is manifest. Strikingly great is the agreement with the uncrystallized type B from Långban, with which the Långbanite from the Sjögrufva also presents the greatest external resemblance. A circumstance which I find very remarkable, is that the percentage of $Sb_2 O_3$ is almost the same in the mineral from the Sjögrufva and that from Långban, the mineral from the Sjögrufva containing 12.81 $^0/_0$, the Långban mineral type A 12.91 $^0/_0$, and type B 11.76 and 11.61 $^0/_0$; equally great is the agreement, if the figures indicating the molecular ratio are compared. This seems to me to speak strongly against the assumption that $Sb_2 O_3$ is present as an isomorphous mixture-ingredient, for, if that were the case, greater variations in the percentage of $Sb_2 O_3$ might be expected. Moreover, the assumption that $Sb_2 O_3$ isomorphously replaces $Fe_2 O_3$ and $Mn_2 O_3$, is in itself not very probable owing to the essentially different chemical properties of these substances.

I have, therefore, tried to find for the mineral a formula in which the constituent $Sb_2 O_3$ entered in a fixed proportion to the other constituents, but have not succeeded in reaching a simple and probable result.

$Sb_2 O_3$ is, in fact, the most constant of all the constituents of Långbanite, as regards the percentage amount. This is manifest from the three analyses of the Långban mineral previously published by me, and is further confirmed by a comparison with the last-published analysis. To facilitate this comparison, I have preferred to bring the constituents together into sesquioxides of the formula $R_2 O_3$ and silicates of the formula $\overset{II}{R} Si O_3$, which comes to the same thing as the writing used above. I give only the figures of the molecular ratio, as they are the most important for the comparison.

	Långbanite Sjögrufva	Långbanite Långban		
		Type B		Type A
		Anal. I	Anal. II	Anal. III
$Sb_2 O_3$	43	41	40	45
$Fe_2 O_3$	87	88	89	27
$Mn_2 O_3$	297	312	317	407
$Mn Si O_3$	141	124	132	102
$Ca Si O_3$	43	40	36	35
$Mg Si O_3$	28	40	21	12
	639	645	635	628

Hence it is visible that the agreement between the Sjögrufva Långbanite and type B from Långban is very great, and greater than it would in all probability be, if the mineral were an isomorphous mixture, with $Sb_2 O_3$ as a component. I am not, therefore, quite satisfied with the interpretation given simultaneously by myself and mr BÄCKSTRÖM[1], without being able, however, to propose a more acceptable one at present. To this may be added that this formula is hardly supported by the crystallographic form of the mineral, which does not easily admit of being compared with that of any other group of minerals.

The composition of the Långbanite from the Sjögrufva is expressed by the wholly empirical formula $Sb_2 O_3 . 9 Mn_2 O_3 . 5 Mn Si O_3$, which also very closely corresponds to the composition of type B from Långban; type A may be said to correspond approximately to the formula $Sb_2 O_3 . 10 Mn_2 O_3 . 3 Mn Si O_3$. In both these formulae $Mn_2 O_3$ is in part replaced by $Fe_2 O_3$, and small amounts of $Mn Si O_3$ by $Ca Si O_3$ and $Mg Si O_3$. These formulae are not, of course, meant to express in any way the constitution of the mineral.

19. Prolectite, a New Mineral of the Humite Group.

(Pl. IV. Figs. 10—12.)

In a previous paper on Humite, Chondrodite and Clinohumite from Nordmark[2] I mentioned by the way the occurrence of a mineral whose crystallographical form did not seem to accord with that of any humite-mineral as yet known[3]. The amount of material, consisting only of two crystal fragments which could not even be said to be well developed, was, however, so inconsiderable, that I found it advisable to examine carefully the available material of humite-minerals from Nordmark to see if anything more of it could be found. In spite of a close search for more material I have not, however, succeeded in finding any more crystals of the same kind. Hence, the description given below is founded on the investigation of a very imperfect material, and, as a consequence of this, the description cannot be complete in every point, nor can my interpretation of the crystals claim infallibility. Above all, I was obliged to desist from a chemical examination, the whole of the material available having been consumed in making the optical determinations necessary for ascertaining the correctness of the purely crystallographical ones.

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[1] Geol. Fören. Förh. Vol. 13, p. 271.

[2] Bull. of Geol. Inst. of Upsala. Vol. I, p. 16; Contributions to Swedish Mineralogy, Part. I, p. 16.

[3] I quote here literally my remarks on this mineral l. c. p. 40: "A further communication will give the results of the chemical examination of the three humite minerals from Nordmarken as well as of their products of alteration. I shall also then have an opportunity to give an account of some interesting crystals, which I have not hitherto been able to identify with any of the above described minerals. It seems that they differ from them both in angles and optical properties and should thus constitute a new species of the humite group."

Figs. 11 and 12 on Pl. IV give a true representation of the two crystal fragments, though on an enlarged scale. Their size was only about 0.01 m. in the greatest dimension. They had the same brownish grey colour as the other humite-minerals from the same locality; in places, however, they had assumed a darker, nearly black colour, owing to admixture of foreign material or to decomposition. The faces were not very brilliant and only imperfectly fit for measurements. Through admixed impurities the crystals were partly not pellucid; even if the amount of material had been greater, it would not have been suited for an accurate chemical investigation.

The crystals were at first supposed to belong to the species of clinohumite. What called the attention to the peculiar character of the find, was the fact, that in measuring the two crystals an angle of 38° 1′ and 38° 2′ was found between the face which, as the crystals were developed, was to form the basal plane A, and a surface of the e-series, which value of angles is not met with in any other humite-mineral. Further measurements gave the result that also with regard to the angles in other zones there were differences which made it impossible to refer the crystallographic form to any one of the other humite-minerals. On a complete measurement of the crystals there occurred in every zone such values of angles as are not met with on any other mineral of the humite group. While only one or two measurements are generally needed to decide whether a crystal belongs to the species of humite, to that of chondrodite, or that of clinohumite, it was impossible to find on these crystals any angles agreeing with those of the said minerals.

Nor did the assumption, which, indeed, lay very near, of a twinning along a face in the e-zone prove conducive to a simple interpretation of these crystals. The only thing, then, that remained, was to try to refer them to a new system of axes, assuming, as in the humite group in general, the *a*- and *b*-axes to be the same as in the other species, while giving a different value to the *c*-axis. As the *c*-axes of chondrodite, humite and clinohumite are in the ratio of 5 : 7 : 9, I tried for the new crystal find an axial system the *c*-axis of which was $^3/_5$ of that of chondrodite, and this system was found to give rational and pretty simple values of indices. This system of axes, which has therefore been accepted provisionally and until a greater amount of material admits of a closer investigation, is

$$a : b : c = 1.0803 : 1 : 1.8862.$$

In the following table I have arranged together the angles observed and those calculated from the given system of axes.

Table of angles.

	Crystal 1	Crystal 2	Calculated
$A:i$		(46° 41)	43° 20
$A:2i$	(63° 25)		62 5
$A:C$	89 15	89 47	90 0
$:C$	89 30		» »
$:+\frac{1}{3}e$		30 9	30 5
$:-\frac{4}{9}e$	37 59	38 2	37 41
$:-\frac{4}{9}e$	38 1	38 5	» »
$:+\frac{5}{3}e$	70 21	70 51	70 57
$:-n$		(69 35)	68 17
$:-\frac{2}{3}n$		60 15	59 44
$:-\frac{2}{7}n$		37 30	36 17
$:\frac{1}{2}o$		(87 17)	90 0
$:\frac{3}{2}r$	81 26		80 53
$:-r$	(75 30)	76 28 *	76 28
$:-r$		76 34	» »
$:+r$		78 30	» »
$:+\frac{3}{7}r$	61 21	59 24 **	60 41
$:+\frac{3}{7}r$		59 15	» »
$:-\frac{2}{9}r$	42 26	42 34	42 44
$:-\frac{2}{9}r$		42 20	» »

* the measured angles vary from 75° 56′ to 79° 51′.

** besides these also two angles 59° 2′ and 58° 44′.

As is seen from this table, the differences between measured and calculated angles is pretty great, which may be due either to the unsatisfactory development of the faces or to the proposed axial system not being the true one. The angles in brackets are determined through shimmer-measurements.

Besides the forms given in the above table of angles, several others occur; these forms are more or less uncertain.

Hence, the determinable number of occurring forms is 16, *viz.*

The pinacoids $A\,(001)\,0\,P$, $C\,(010)\,\infty P \infty$;
the orthodomes $+\frac{1}{3}e\,(103) - \frac{1}{3}\bar{P}\infty$, $-\frac{4}{9}e\,(409) + \frac{4}{9}\bar{P}\infty$, $+\frac{5}{3}e\,(503) - \frac{5}{3}\bar{P}\infty$;
the clinodomes $i\,(012)\,\check{P}\infty$, $2i\,(014)\,2\check{P}\infty$;
the pyramids of the fundamental series $-n\,(\bar{1}11) + P$, $-\frac{2}{3}n\,(\bar{2}23) + \frac{2}{3}P$, $-\frac{2}{7}n\,(\bar{2}27) + \frac{2}{7}P$;
the clinodiagonal pyramids $-r\,(\bar{1}21) + 2\check{P}2$, $+r\,(121) - 2\check{P}2$, $+\frac{3}{2}r\,(322) - 3\check{P}2$, $+\frac{3}{7}r\,(327) - \frac{6}{7}\check{P}2$, $-\frac{2}{9}r\,(\bar{2}29) + \frac{4}{9}\check{P}2$;
the prism $\frac{1}{2}o\,(110)\,\infty P$.

A comparison between the symbols for these forms and those for the corresponding forms of the other minerals of this group suggests the following observations:

The ortodomes (*e*-series) are represented by $+\frac{1}{3}e$, $-\frac{4}{9}e$, $+\frac{5}{3}e$; on the clinohumite occur in this series $\pm e$, $\pm\frac{1}{3}e$, $\pm\frac{1}{5}e$, $\pm\frac{1}{7}e$, $\pm\frac{1}{9}e$; consequently great regularity prevails there. Less is the regularity in the chondrodite, where, besides the regular $\pm e$, $\pm\frac{1}{3}e$, $\pm\frac{1}{5}e$, we also meet with $2e$, $\frac{4}{3}e$, $\pm\frac{3}{5}e$. The $\frac{1}{3}e$ of the prolectite belongs to the regular series, while $+\frac{5}{3}e$ and, in a still higher degree, $-\frac{4}{9}e$ are among the irregularities of which instances are found on the chondrodite.

The clinodomes (*i*-series), represented by i and $2i$, present nothing remarkable.

The pyramids of the *n*-series exhibit on chondrodite as well as on clinohumite a strict regularity, occurring as $\pm n$, $\pm\frac{1}{3}n$, $\pm\frac{1}{5}n$, $\pm\frac{1}{7}n$; the only exception from this is $\frac{1}{2}n$ and $\frac{2}{3}n$ on chondrodite. On prolectite only $-n$ harmonizes with this series; of the remaining two, which deviate from it, at least one is uncertain: $-\frac{2}{7}n$ may possibly be $-\frac{1}{3}n$, which would be in better harmony with the series.

Proceeding, finally, to the faces of the *r*-series, we find in the chondrodite as well as in the clinohumite the same strict regularity, the occurring faces being: $\pm r$, $\pm\frac{1}{3}r$, $\pm\frac{1}{5}r$, $\pm\frac{1}{7}r$, $+\frac{1}{9}r$, $-\frac{1}{11}r$, $+\frac{1}{13}r$, $-\frac{1}{15}r$.- Harmonizing with this series we find on the prolectite $+\frac{3}{2}r$ and $\pm r$; $+\frac{3}{7}r$ and $-\frac{2}{9}r$ present exceptions from this regularity, which exceptions, however, are no more striking than the occurrence of $+\frac{2}{7}r$ on chondrodite.

This review shows that the symbols for the faces, according to the axial system chosen, exhibit, on the whole, the same characteristical regularities that distinguish the other minerals of this group, though far less strongly marked.

The observed exceptions and irregularities are hardly more remarkable than those occurring in chondrodite and are probably in part accounted for by the imperfect development of the crystals. As hitherto only two fragments of crystals could be subjected to examination, it may be deemed very likely that, when an ampler supply of material can be obtained, the gaps that most of the zones now present, will be at least in part filled.

Though already the result of the crystallographical examination was considered as a proof that the crystals could not be referred to any of the hitherto known humite-minerals, yet it was thought advisable to seek a control and confirmation of this by an investigation of their optical properties. For this purpose sections parallel to the plane of symmetry were cut, first of one, then of the other crystal.

The examination of plate No. 1 in parallel polarized light first showed it to be simple and without any twin lamellae; hence, the interpretation according to which the peculiar form of the crystals was to be explained by the assumption of a complex twinning is inadmissible. In the stauroscope the extinction-directions were found to make angles of 42° 45′ and 47° 15′ with the basal plane A. The examination in convergent polarized light gave an axial figure with a large axial angle; the plane of the optic axes makes an angle of 47° 15′ with the basal plane. The acute bisectrix is, as in the other humite-minerals, positive.

The other plate also was found to be simple, and the stauroscopic measurement gave an angle of about 44° between the plane of the optic axes and A. The position of the optic axial plane agrees with the position of the same plane in the other humite-minerals, in as much as it corresponds to a hemidome with the symbol $+\frac{1}{n}e$ $(10\,n)$[1]; but it deviates from the latter with respect to the angle that it makes with A, which angle is in

Humite	from Nordmark	0° 0
Chondrodite »	»	27° 30′
Clinohumite »	»	12°—15°
Prolectite »	»	44°—47°.

This confirms that the mineral is distinct from the other humite-minerals.

With this the optical orientation is perfectly clear. The acute bisectrix, being positive, is at the same time the axis of least elasticity $\mathfrak{c}$; it is consequently the axis of greatest elasticity $\mathfrak{a}$ that lies in the plane of symmetry, making an angle of 45°—47° 15′ with A or an angle of 46°—42° 45′ with the vertical axis *c*.

The acute axial angle was measured in Thoulet's solution with an index of refraction for Na-light of Ng = 1,6703 with the following result:

$$2K_{ar} = 80^{\circ}\,10'$$
$$2K_{ay} = 79^{\circ}\,45'$$
$$2K_{agr} = 79^{\circ}\,20'.$$

For the sake of comparison I state that, according to my previously published measurements, the optic axial angles for Na-light, measured in the same liquid, are

for	Humite	from Nordmark	66° 40′
»	Chondrodite »	»	77° 50′
»	Clinohumite »	»	76° 27′,
to which may now be added	Prolectite		79° 45′.

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[1] As for the position of the plane of the optic axes in chondrodite and humite, which frequently is incorrectly stated in the literature, I refer the reader to my papers No. 4 and No. 5 in these Contributions, part I, p. 34 and 39.

Also in this respect the prolectite is found to differ somewhat from the rest of the humite-minerals.

Having thus shown that the prolectite is both geometrically and optically distinct from the other minerals of the humite group, we may proceed to a consideration of its chemical relation to them.

By PENFIELD and HOWE on the one hand and by myself on the other it has been independently and almost simultaneously shown that the three minerals of the humite group have different formulae and that these formulae have a close relation to their crystallographical forms[1].

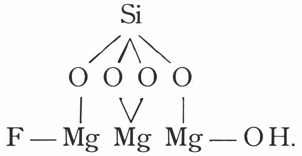
The formulae are:

$$\begin{aligned}\text{Chondrodite} &= Mg_3[Mg(F.OH)]_2[SiO_4]_2\\ \text{Humite} &= Mg_5[Mg(F.OH)]_2[SiO_4]_3\\ \text{Clinohumite} &= Mg_7[Mg(F.OH)]_2[SiO_4]_4\end{aligned}$$

The vertical axes of the three minerals are in the ratio of 5 : 7 : 9, which is also the ratio between the Mg atoms of the different formulae; and as, provided that the result of the above crystallographical investigation be correct, the vertical axis of the prolectite is to that of the clinohumite as 3 to 9, we may, on the assumption that the law also holds good with regard to the new mineral, deduce for the prolectite the following formula

$$Mg[Mg(F.OH)]_2SiO_4$$

with a constitution made clear by the following scheme:



It would, of course, have been of the greatest interest to be able to ascertain by analysis this composition of the mineral. As, however, the whole of the material available was used for the optical investigation, the chemical analysis must be postponed till a larger amount of material can be obtained.

That the find of a mineral with this composition might be expected, has already been predicted by PENFIELD and HOWE[2]; for aught I

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[1] The article of PENFIELD and HOWE was published in the March number of American Journ. of Science 1894, Vol. XLVII, p. 188, mine in May of the same year as a reprint from Bull. of Geol. Inst. of Upsala. Vol. II.

[2] I quote the words of my American colleagues verbally: "In the whole range of chemical crystallography there is no series of compounds known to the authors that can be compared to the humite group. It is reasonable to expect that other members of this series will be found. Thus $Mg[Mg(F.OH)]_2SiO_4$ is a possible and a most likely compound to

know, this is the first time in the history of mineralogy, that it has been possible to foretell the existence of a mineral of a certain crystallographical form and its composition. The name of the mineral (from προλέγειν = to foretell) has been chosen in allusion to this circumstance.

Summary and characterization of the new mineral prolectite. Among the large amount of material of humite-minerals from Nordmark were found two crystals which did not agree in crystallographic form with any one of the known minerals of the humite group. In appearance and physical properties the agreement with the humite minerals was perfect. An optical examination confirmed the assumption that a new mineral had been found. With the axial system $a : b : c = 1.0803 : 1 : 1.8862$, in which the horizontal axes are equal and the vertical axis is $^1/_3$ of that of clinohumite (= $^3/_7$ of that of humite and $^3/_5$ of that of chondrodite), the symbols of the occurring faces are:

$$A(001),\ C(010),\ +\tfrac{1}{3}e(103),\ -\tfrac{4}{9}e(409),\ +\tfrac{5}{3}e(503),\ i(012),\ 2i(014),\ -n(\bar{1}11),$$
$$-\tfrac{2}{3}n(\bar{2}23),\ -\tfrac{2}{7}n(\bar{2}27),\ -r(\bar{1}21),\ +r(121),\ +\tfrac{3}{2}r(322),\ +\tfrac{3}{7}r(327),\ -\tfrac{2}{9}r(\bar{2}29),$$
$$\tfrac{1}{2}o(110),$$

which symbols agree approximately with the rules for the humite-minerals. The optic axial plane makes an angle of 44°—47° 15′ with the basal plane; hence, the optical orientation is $\mathfrak{B}x_0 \wedge \acute{c} = \mathfrak{a} \wedge c = -46°$ to $-42° 45'$ or $\mathfrak{b} \wedge c = 44°$ to 47° 15′.

The optic axial angle, measured in Thoulet's liquid with an index of refraction ng = 1.6703, is 79° 45′ for yellow light. According to the law manifested in the other humite-minerals the composition of the mineral should be $Mg[Mg(F, OH)]_2SiO_4$, if the above interpretation of the crystalline form is correct, but it has not been possible to analyze the mineral from want of material. It occurs together with clinohumite and the other humite-minerals at the Kogrufva, Nordmark.

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occur. This should crystallize either orthorhombic or monoclinic with $\beta = 90°$ and should have the axial ratio $a : b : c = 1.086 : 1 : 1.887$. The member next beyond clinohumite would be $Mg_9[Mg(F \cdot OH)]_2[SiO_4]_5$ but, owing to its more complicated composition, it would seem less apt to occur." (Amer. Journ. of Sc. III, Vol. XLVII, p. 204.)

Addition to No. 15 Urbanite.

After the article on urbanite had already been printed, I received the 6th number of Groth's Zeitschrift, Vol. 23, 1894, in which I find a description of the urbanite from Glakärn published by mr IGELSTRÖM, who proposes the name Lindesite for this mineral[1]. To this article of mr IGELSTRÖM's I find myself called upon to subjoin a few remarks.

IGELSTRÖM, who cites my previous article in Geol. Fören. Förhandl. on urbanite from Långban[2], finds it possible that the minerals from Glakärn and Långban are identical. Had his analysis been correct, he could not have been in doubt about that. He then thinks he may claim the credit of the prior discovery of the mineral. The reasons on which he grounds this opinion are somewhat singular. His words on page 592 are: »Sollten die beiden Mineralien vereinigt werden können, so möchte ich den Namen Lindesit beibehalten, weil ich glaube, dass mir die Priorität gebührt, indem ich dieses Mineral schon im Jahre 1870 aufgefunden, wenn auch nicht richtig gedeutet habe und weil ich zweitens vor etwa zwei Jahren schon eine Analyse an die Geol. Fören. in Stockholm eingesendet habe, welche aber nicht veröffentlicht worden ist.»

As for the first of these reasons — that mr IGELSTRÖM found the mineral already in 1870 —, it is of no consequence, I dare say, when mr IGELSTRÖM *found* the mineral; what decides the priority is the time when a description of a mineral, correct in the essential points, *is published*. My description of urbanite from Långban was published in March 1892, IGELSTRÖM's description of the so called Lindesite from Glakärn (= urbanite) in Dec. 1894; it is, therefore contrary to the general rules that mr IGELSTRÖM claims the priority of the discovery of the mineral and the preference of the name Lindesite given by him to the name given by me[3].

The second reason which mr IGELSTRÖM adduces in support of his claims to priority is, that he »sent already two years ago to the Geol. Fören. in Stockholm an analysis, which was not, however, published». If it really was two years ago that mr IGELSTRÖM sent his analysis to the Geol. Fören. in Stockholm, this would consequently have happened at some time during the latter half of the year 1892. As, however, my description of urbanite from Långban was printed as early as March 1892, this circumstance cannot, evidently, be alleged in favour of his claims. But even if mr IGELSTRÖM sent his analysis at an earlier date, as, indeed, I think he

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[1] Zeitschr. für Krystallogr. etc., Vol. 23, p. 590, 1894.

[2] Geol. Fören. Förhandl., Vol. 14, p. 251, 1892.

[3] If in the present case application were to be made of the principle proclaimed by IGELSTRÖM, that the credit of priority is due to him who has first *found* the mineral, this credit would not, at all events, be due to IGELSTRÖM, but to BREITHAUPT, who, as has been shown above, had the mineral in his hand and caused it to be analyzed by WINKLER as early as 1865; but BREITHAUPT lost his priority by erroneously identifying the mineral with schefferite.

did, that makes no difference, since *the publication of this analysis was inhibited with mr Igelströms own consent.* On sending me material for a crystallographical examination, mr IGELSTRÖM wrote in a letter to me that it was desirable that I should cause the mineral to be analyzed, because he had no confidence in his own analysis, being particularly uncertain as to the determinations of the alkalies and as to whether the whole of the iron were present as a sesquioxide. This uncertainty on the part of mr IGELSTRÖM as to the correctness of his own analysis was the cause of its not being published in Geol. Fören. Förhandl., though it now appears, uncorrected and without any allusion to its possible inaccuracy, in Groth's Zeitschrift.

From the above it would seem to be clear enough that mr IGELSTRÖM cannot claim the priority as regards the mineral urbanite, but only as regards the discovery of its occurrence at Glakärn. The uncrystallized variety of urbanite which occurs at Glakärn *might* certainly be designated by the name Lindesite, but the agreement in composition and optical properties between the Långban and the Glakärn mineral is, as has been shown in the foregoing, so complete, that I consider a special name for the variety quite unnecessary.

That IGELSTRÖM's doubt as to the accuracy of his analysis was not groundless, will appear from a comparison between his analysis and that of MAUZELIUS, published above (p. 85). The most conspicuous points of difference are presented by the amounts of Fe_2O_3, MnO and Na_2O. That IGELSTRÖM's analysis is not such as to have enabled him to come to a true conclusion as to the chemical constitution of the mineral, is especially shown by what he says about the mineral in the paper he sent to the Geol. Fören. in Stockholm and which was not published, namely that it is »a molecular compound of rhodonite substance with feldspar substance». It is only in his article in Groth's Zeitschrift, consequently after I had published my paper on the urbanite from Långban, that he finds that the mineral may be regarded as allied to acmite. How this inference can be drawn from the analysis published by IGELSTRÖM in Groth's Zeitschrift and the formula deduced from it, is, however, incomprehensible. The formula suggested by IGELSTRÖM is $3RO\,SiO_2 . R_2O_3SiO_2$ (in which RO is CaO, MnO, MgO, Na_2O, and R_2O_3 is chiefly Fe_2O_3). The formula proposed by me for urbanite is, if written in uniformity with that of IGELSTRÖM, $2RO\,SiO_2 . R_2O_3\,3SiO_2$, and it is on the basis of this formula that I have illustrated the chemical constitution of the mineral by comparing it with one molecule of rhodonite + one molecule of acmite silicate.

In his description l. c. p. 595 mr IGELSTRÖM says: »Der Lindesit findet sich in Krystallen, welche bis zu 3—4 cm. Länge und 2 cm. Breite und Dicke erreichen.» As mr IGELSTRÖM has sent me material for crystallographical investigation, I cannot but presume that he has sent me of the best crystallized, or, at least, of typical material. The material I have received from him is, however, *not* crystallized in the common sense of the word, but consists of imbedded idiomorphic grains, but without crystalline faces. If the sense which mr IGELSTRÖM gives the word »crystallized» were accepted, every porphyric feldspar grain in granite were to be designated as crystallized. Owing to the nature of the material the crystallographical investigation was confined, as stated above, to a measurement of the angle of cleavage. In this respect, therefore, mr IGELSTRÖM's statements have to be corrected.

At last I cannot forbear noticing an error that has crept into mr IGELSTRÖM's article. On page 591 he says: »Aus der neuerdings veröffentlichten Untersuchung des sog. »Eisenschefferits» von Långban durch H. Sjögren, welcher *dieses Mineral* nicht als zum Schefferit gehörig betrachtet, sondern als ein neues auffasst und mit dem Namen Urbanit belegt — — — —»; this implies that I do not acknowledge the existence of any iron schefferite, but refer the iron schefferites to urbanite. This is, however, a misrepresentation, as, on the contrary, I mention in my article not only the common schefferite, but also the existence of iron schefferite from Långban and Pajsberg analyzed and described by FLINK, to which, however, I add urbanite as a new species.

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Magnetite Fig. 1—3.

Fig. 1.

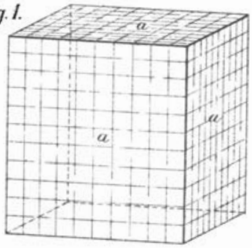


Fig. 2.

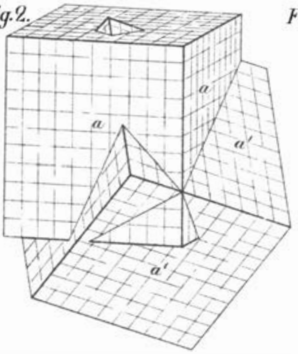


Fig. 3.

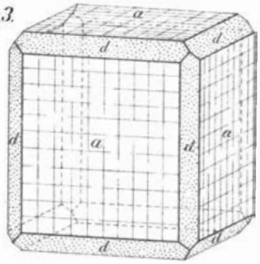
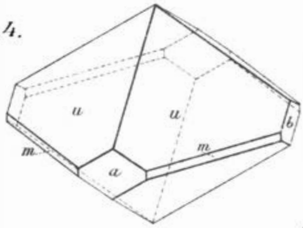


Fig. 4.



Urbanite Fig. 4—6.

Fig. 5.

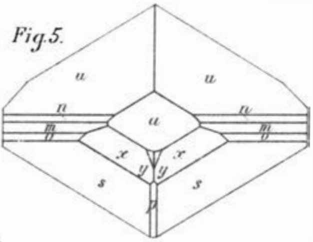
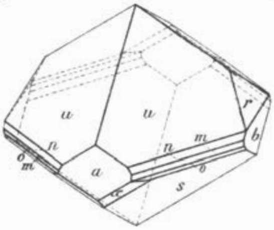


Fig. 6.



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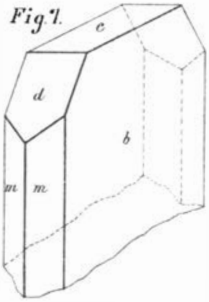
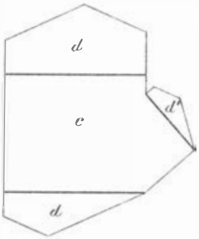


Retzian Fig. 7—12.

Fig. 8.



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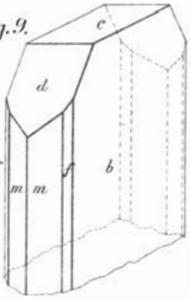
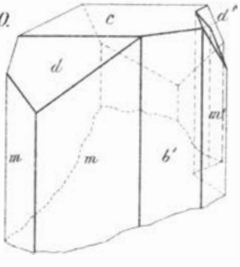


Fig. 11.

Fig. 10.



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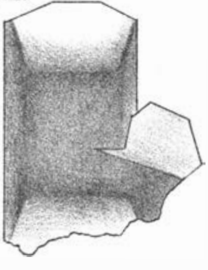


C. Morton del.
Lith. L. L. Ljunggren.

HJ. SJÖGREN. Pyroaurite, Safflorite, Soda berzeliite, Prolectite. Pl. IV.

Pyroaurite Fig. 1—5.

Fig. 1.

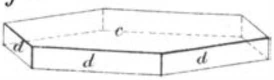


Fig. 2.

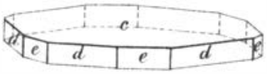


Fig. 3.

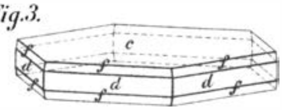


Fig. 4.

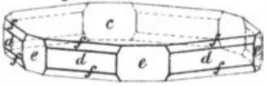
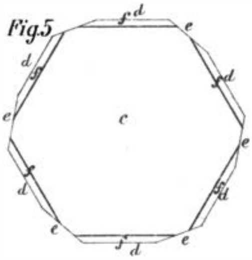


Fig. 5.



Safflorite Fig. 6—7.

Fig. 6.

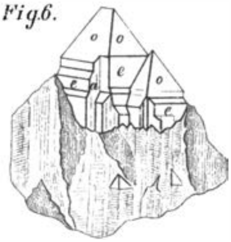
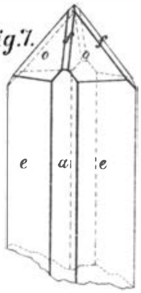


Fig. 7.



Soda berzeliite Fig. 8—9.

Fig. 8.

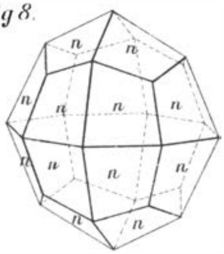


Fig. 9.

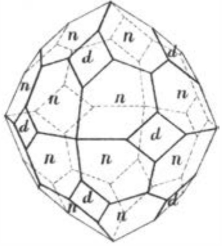
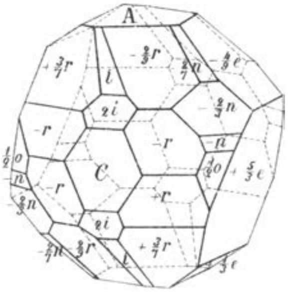


Fig. 10.



Prolectite Fig. 10—12.

Fig. 11.

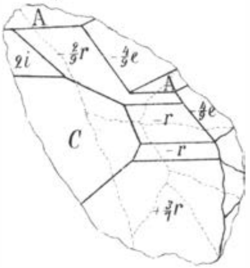
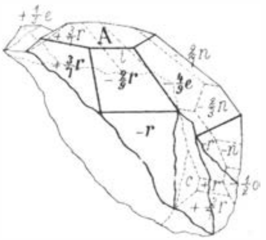


Fig. 12.



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