MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
BD. 149 · NR. 3

THE MINERALOGY OF GREENLAND

BY

O. B. BØGGILD

WITH 88 FIGURES IN THE TEXT AND 1 MAP

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
1953

CONTENTS

	Page
Preface	5
1. Elements	12
2. Sulphides and Arsenides	39
3. Chlorides and Fluorides	64
4. Oxides and Hydroxides	99
5. Carbonates	136
6. Sulphates etc.	162
7. Phosphates and Arsenates	175
8. Silicates	184
9. Organic Compounds	426
Alphabetical List of the Localities	428
Aphabetical List of the Minerals	436
Addenda and Corrigenda	438

PREFACE

During the years which have elapsed since the publication of "Mineralogia Groenlandica", 1905, vol. 32 of "Meddelelser om Grønland", a large number of new localities for minerals have been discovered, and rather considerable quantities of minerals have been sent home from Greenland. These minerals originate from different sources. A good deal of them have been collected by the various scientific expeditions, more particularly by the two Nûgssuaq-Expeditions in 1938 and 1939 under the leadership of ALFRED ROSENKRANTZ; also great quantities of minerals have been obtained by the members of the expeditions sent out by "Grønlandsk Minedrifts Aktieselskab", under the leadership of Mr. J. BERNBURG, Merchant, and Mr. IB NYEBOE, Civil Engineer. Also a great amount of material has been sent home by Mr. M. PORSILD, M. Sc. from the Biological Station at Godhavn, and by Mr. O. R. B. HANSEN, former manager, Chief Assistant from Godhavn, while Mr. K. FÆSTER, Civil Engineer, has collected great quantities of material for the Mineralogical Museum of Copenhagen. As late as during the years immediately succeeding 1905 several collections of partly very valuable minerals were sent from Narssârssuk; but since then this collecting of material has ceased, and it seems that all the occurrences there have been exhausted, at any rate as far as the more easily accessible minerals are concerned. And last, but not least, mention must be made of the great number of mineralogical specimens which are still pouring in from Ivigtut and being placed at the disposal of scientific investigators by the "Kryolith Mine og Handels Selskabet" and "Øresunds Chemiske Fabriker"; the overwhelming material from these sources, which in part consists of highly mixed and not very easily distinguishable minerals makes it impossible, with a view to the present work, to undertake a fairly complete examination of the material at hand; such an examination must be postponed pending further investigations of a specialized kind.

A considerable amount of material has naturally been collected in East Greenland by the numerous expeditions of later years, whereas in former times only the southern part was fairly well known. The

examinations already made, however, rather seem to point in the direction that this part of the coast, when fully investigated, will not be able to compete with the west coast as regards mineral wealth.

I first intended to publish a supplement to "Mineralogia Groenlandica" with a description of all the recently added occurrences; but there are three reasons which made me decide to undertake a new edition of the entire work. In the first place, the first edition was in Danish, which made it less generally useful; in the second, it is very nearly sold out, and thirdly, "Mineralogia Groenlandica" is in certain respects in need of revision.

I have considered it expedient to omit some of the less interesting occurrences and to shorten the description of others, so as to make room for new and interesting occurrences, without having to increase the size of the book.

As far as West Greenland is concerned, the geological conditions are rather uniform, and as to mineralogical importance the formations will in the main be divided into three classes. By far the greater part of the country consists of the Archean, particularly gneisses and granites with their pegmatite veins; a smaller part, more especially from the peninsulas of Svartenhuk and Nûgssuaq and the island of Disko, is built up of plateau basalt, several km thick, with inclosed sediments and overlying a series of sediments about 2 km thick. Of far smaller extent, but of extreme mineralogical interest is a third element viz. the intrusions, probably of Palæozoic age and mostly consisting of batholiths of alkaline rocks, which chiefly occur in the southernmost part of Greenland.

As elsewhere, the occurrences of minerals in the Archean chiefly consist of pegmatite veins, although also other formations may be of interest in this respect. The Greenland pegmatite veins do not seem to be particularly rich in minerals; it will, however, be possible to enumerate a great number of minerals from such veins, but by far the greater number occur only once or very few times, and then in very small quantities. A special kind of vein is that which chiefly consists of pale pyroxenes and amphiboles, and which represents a particular enrichment of magnesia. Such veins are particularly common in the environs of Upernavik, in certain parts of the Umanak district, in the Christianshaab and Egedesminde districts and the southern part of the Godthaab district, as well as in the neighbourhood of Angmagssalik. These formations reach their climax in the Aunikasik outcrop in the Godthaab district, where a greater mass is found consisting of a mixture of seven minerals, rich in magnesium (enstatite, anthophyllite, olivine, chlorite, phlogopite, magnesite and talc) without any intermixture of other minerals.

Apart from the primary minerals the basalt formation contains first and foremost zeolites, and then quartz, chalcedony, calcite and aragonite. The zeolites are of no special interest; by far the greater number being rather small and insignificant, and there are very few occurrences of the rarer kinds. Of other, not very common minerals may be mentioned the wollastonite and the pectolite from Nûgssuaq and the native iron from Uivfaq and other localities.

The third group of rocks, consisting of the alkaline intrusions are of particular interest from a mineralogical point of view, being associated with nearly all the rarer Greenland minerals. The most famous of these intrusions are the nepheline-syenites, but there are also a great number of small masses of syenite or granite. As to the nepheline-syenites, they are very different in respect of the amount of rare minerals contained in them; some, for instance the Grønnedal batholith and the great Igaliko batholith, have few pegmatite veins; they hardly contain other minerals than the ordinary constituents of the rocks. The rare minerals are chiefly associated with the two famous names, Narssârssuk and Kangerdluarssuk. Narssârssuk is a comparatively small outcrop (about 1 km^2) in the narrow belt of augite-syenite which bounds the nepheline-syenite of the Igaliko batholith towards west; in this locality there is no nepheline, but great quantities of quartz, which possibly owe their existence to the influence of adjacent sandstone, but on the whole the minerals are those typical of the nepheline-syenite pegmatites. As distinct from Narssârssuk, Kangerdluarssuk is a rather large area, and the rare minerals are contained in the nepheline-syenite classified by Ussing[1]) as naujaite.

An enumeration of the minerals from these two localities and a comparison with occurrences of minerals in other places will give an interesting picture of existing conditions. From Narssârssuk 45 minerals are known, of which 8 are not to be found elsewhere, while 13 must be regarded as very rare i. e. are only found in very few other localities. Of these 13 minerals four are found in the nepheline-syenite pegmatite veins in the Oslo Region and five in the corresponding formations at Kola, as against five found in other scattered localities. From Kangerdluarssuk 34 minerals are known, five of which have not been

[1]) Medd. om Grønl. 38, 1912, where all details regarding these localities are to be found. The name Kangerdluarssuk is used in two senses, viz. partly for the actual fjord of Kangerdluarssuk, and partly for the area of nepheline-syenites extending from K. across the more northerly Tunugdliarfik Fjord. In the following a distinction will be made between "K." and "the region of K.", but the names have been used indiscriminately by many writers, as well as on the labels in the Mineralogical Museum of Copenhagen; this, however, does not cause any great disturbance, as the mineralogy of the area is rather uniform.

identified elsewhere and eight of which are very rare; two of them being common to Kangerdluarssuk and Norway, three to K. and Kola, whereas four have been found in various scattered localities. To this may be added that four minerals are common to both localities, viz. Narssârssuk and Kangerdluarssuk, and that seven are common to Norway and Kola. Thus one gets a strong impression that there is a good deal of relationship between the occurrences in Greenland, Norway and Kola, and also that there is no other locality in the world, where conditions are analogous with those mentioned from there.

When considering the elements characterizing the two occurrences mentioned above, one is struck by the close agreement between them. Ussing (l. c. p. 249) has published a table, from which the following extracts are taken. Zirconium is found in very great quantities at Kangerdluarssuk, in smaller at Narssârssuk; titanium occurs abundantly in both localities; the cerium metals are found in large quantities at K.; in smaller at N.; niobium occurs in insignificant quantities at K., beryllium in fairly great quantities at N., in quite negligible quantities at K.; lithium is found in both localities, particularly in great quantities at K. To this it may be added that the elements barium and strontium are found in small quantities at N., but not at K. As was perhaps also to be expected, a common feature of both occurrences is that nearly all the rare minerals contain sodium as an essential constituent, whereas potassium occurs in considerably smaller quantities and in most cases is entirely absent.

The same group of rocks, which have been treated here, may also be said to include the cryolite bed at Ivigtut, the third famous depository of rare minerals in Greenland. From Ivigtut 34 minerals are known, ten of which, all of them double fluorides, must be regarded as rare; two of them are not found at any other locality, eight are almost confined to the smaller cryolite occurrences in the Urals and Colorado. All of these minerals contain aluminium and sodium, and furthermore calcium, magnesium, lithium, strontium and barium occur. Quartz, siderite and most of the ordinary sulphides, besides topaz and fluorite, are to be found embedded in the cryolite. The cryolite is surrounded by a pegmatite containing a number of different minerals, of which cassiterite, wolframite and columbite are to be mentioned. A peculiar feature of the occurrence is that the silicates, which generally constitute the main part of most pegmatites, are here only found as quite small quantities of microcline, topaz and two micas; it is particularly striking that the felspar, which is otherwise found in great quantities, is an almost pure potassium felspar, although the bed contains particularly abundant sodium.

In the following, a list is given of all the elements known from

Greenland; the numbers lacking in the list have not yet been found in the Greenland minerals. The most common elements are merely mentioned without more detailed specification, for the others there is a statement of the names of the minerals in which they occur; by examining the latter it will thus be possible to get an idea of the abundance of the element in question.

1. H.

2. He, found in fluorite from Ivigtut.

3. Li. Polylithionite, tæniolite, cryolithionite.

4. Be. Steenstrupine, beryl, leucosphenite, epididymite, eudidymite, gadolinite.

5. B. Tourmaline, dumortierite.

6. C — 7. N — 8. O — 9. F — 11. Na — 12. Mg — 13. Al — 14. Si — 15. P — 16. S.

17. Cl, Halite, atacamite, sodalite.

19. K — 20. Ca.

22. Ti. Ilmenite, perovskite, chalcolamprite, endeiolite, rutile, euxenite, rinkite, lorenzenite, titanite, epistolite, astrophyllite, catapleiite, neptunite, leucosphenite, kaersutite, ænigmatite, narsarsukite.

24. Cr. Chromite.

25. Mn. Pyrolusite, rhodochrosite, steenstrupine, schizolite, eudialyte, ænigmatite, spodiophyllite.

26. Fe.

27. Co. Iron, cohenite, pyrrhotite, erythrine.

28. Ni. Iron, cohenite, pentlandite, pyrrhotite, millerite, bravoite, zaratite, annabergite.

29. Cu. Copper, iron, chalcocite, bornite, chalcopyrite, pyrrhotite, stannite, tetrahedrite, luzonite, covellite, valleriite, atacamite, azurite, malachite, chrysocolla.

30. Zn. Sphalerite, willemite, calamine.

33. As. Löllingite, arsenopyrite, luzonite.

38. Sr. Jarlite, ancylite.

39. Y. Euxenite, fergusonite, apatite, rinkite, steenstrupine, gadolinite.

40. Zr. Chalcolamprite, endeiolite, rinkite, lorenzenite, elpidite, eudialyte, catapleiite, zircon.

41. Nb. Microlite, chalcolamprite, endeiolite, columbite, euxenite, fergusonite, steenstrupine, epistolite.

42. Mo. Molybdenite, wulfenite.

47. Ag. Silver.

50. Sn. Microlite, cassiterite, fergusonite, columbite.

51. Sb. Tetrahedrite.

56. Ba. Metajarlite-jarlite, cordylite, barite, leucosphenite, stannite.

57—71. The cerium group. Microlite, fergusonite, euxenite, monazite, apatite, britholite, synchysite, cordylite, ancylite, erikite, allanite, rinkite, steenstrupine.

72. Hf. Found together with zirconium.

73. Ta. Microlite, fergusonite, steenstrupine.

74. W. Fergusonite, wolframite, columbite.

78. Pt. Platinum.

79. Au. Gold.

82. Pb. Galena, cosalite, cerussite, steenstrupine.

83. Bi. Bismuth, bismuthinite, cosalite.

88. Ra. Found together with uranium.

90. Th. Synchysite, cordylite, ancylite, allanite, erikite, steenstrupine.

92. U. Fergusonite, euxenite.

As to the manner of quoting from the most generally used literature the following must be observed:

M. o. G. is Meddelelser om Grønland.

GIESECKE's itinerary is quoted with the date and the year of his visit in the locality in question, there being two editions of the book with a different paging:

1. GIESECKES Mineralogiske Rejse i Grønland, ved C. F. Johnstrup, 1878.
2. KARL LUDWIG GIESECKES Mineralogisches Reisejournal über Grönland 1806—1813. 1910, M. o. G., vol. 35.

RINK's Nrg. has the following title: Om den geographiske Beskaffenhed af de danske Handelsdistrikter i Nordgrønland tilligemed en Udsigt over Nordgrønlands Geognosi. 1852.

RINK's Gr. I is Grønland, geographisk og statistisk beskrevet. I. Det nordre Inspektorat; 1 and 2 mean parts 1 and 2 with separate paging.

RINK's Gr. II is the second volume of the same work: Det søndre Inspektorat. Here there is an appendix with separate paging.

The orientation of crystals and the terms used for the faces of the latter will, in the case of the description of the older minerals, always be those used by DANA in his A System of Mineralogy, 1892.

Photographs by Mr. CHR. HALKIER, conservator in the Mineralogical Museum of Copenhagen, if not otherwise stated.

In the spelling of the Greenlandic names I have followed the newer orthography, but as the difference between the older and newer orthography is not very great, I do not think that the alteration will give rise to any confusion. Most obvious is the letter q (kra) which was formerly written as k although the difference between the letters is rather great. The pronounciation of q is given by THALBITZER in M. o. G. 31, p. 75 and in the table p. 81, where it is described as a consonant produced in the rear of the mouth (uvula).

In the following enumeration of all the more important mineral occurrences in Greenland, the name of the first finder and collector of the mineral concerned at the locality named, will be given in parenthesis. The majority of these names will probably be unknown to most of those who will use the present work, but

I mean, however, that it is most proper to include this information for the benefit of those who may visit, or be otherwise concerned with the various localities. There is no reason to give further information about the great majority of these collectors, and I will therefore only say a few words about the three who are undoubtedly the greatest collectors of minerals in Greenland; they have all been able to travel throughout the "whole country" which, in their day, only comprised the southern half of the west coast from Upernavik to the southernmost point.

K. L. Giesecke (1761—1833), a German mineralogist, was sent to Greenland by the Danish Government in 1806 to find valuable minerals. Because of the war with England he was forced to remain there until 1813, and he was therefore able to visit a great many localities, and collect much important material.

H. J. Rink (1819—93), a mineralogist and geologist, travelled in North Greenland from 1848 to 1851. He later (1853—68) became Colony Administrator, and thereafter Inspector for South Greenland, in which region he undertook numerous investigations and collections.

K. J.V. Steenstrup (1842—1913) travelled, during much of his lifetime, to persue mineralogical and geological studies, in the course of which he collected abundant material.

I. ELEMENTS

1. Copper. *Cu.*

The Godhavn district.

Disko Fjord (Rink 1850).

Rink Ngr., p. 57.

Found in very small grains (about 1 mm) in scolezite; the shape irregular, rounded. The copper is associated with smaller quantities of malachite.

2. Silver. *Ag.*

The Julianehaab district.

Storø (Qeqertarssuaq) (found by Greenlanders in 1849).

Rink: Om Monopolhandelen paa Grønland, 1852.

Lundt: Nogle faktiske Oplysninger i Anledning af Planen om Bjergværksdrift paa Grønland, 1852.

Tayler: Peterm. Mitt. 1856, pp. 118—119[1]). Ill. London News 1856, No. 783. Litt. Gazette, No 2039.

Rink: Gr. II, p. 129.

Rather numerous specimens of silver have been found (the Mineralogical Museum of Copenhagen has twenty-five in all, total weight 13.3 g) lying loose in the interstices between the stones in front of a Greenland house, and it does not occur together with any other mineral. The crystals are almost exclusively octahedral, but the faces are in most cases not particularly distinct, being frequently irregular and rounded. The crystals are always developed in the shape of regular and finely branching crystal skeletons, fig. 1, sometimes elongated and prismatic, sometimes tabular. The surface is sometimes silver-white, most frequently with a dark coating.

The origin of the silver is uncertain. The soil in which the samples were found had formerly been the site of a Greenland house, and it is probable that the specimens have been embedded in the turf forming the walls of this house, in which case they must be supposed to have

[1]) Here the locality is erroneously given as Storø southwest of Arsuk.

been lying loose in the immediate vicinity of the house. It may also be imagined that they have been collected by the Greenlanders living in the house, and in that case they may originate from any locality in the region. As the same island contains copper ore, which is reported as being argentiferous, it may perhaps originate from there, but at any

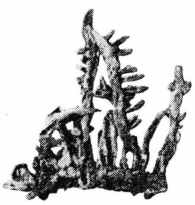


Fig. 1. Silver. Storö 1:1.

rate it is extremely peculiar that no traces of it have been found elsewhere. The island has been visited by several expeditions, both on account of the copper ore and in order to look for silver. Thus LUNDT spent the whole of 1852 there with numerous miners; in 1853 the Englishman ROBINSON stayed there with a number of mineralogists, and in 1854 two Norwegian workmen spent a whole year in the place. These expeditions have collected quite small quantities in the locality where the Greenlanders found the first specimens.

Greenland without any definite locality.

SCHUMACHER: Naturh. Selskab Skr. 4. 2. Hefte 1798, p. 233.

SCHUMACHER: Verzeichniss der in den Dänish-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 147.

RINK: Gr. II, p. 131.

A single specimen weighing about 10 gm, together with a smaller quantity of calcite. The shape fibrous and branching, without crystal faces. The silver is nearly entirely covered with a brownish crust. As to its origin nothing is known, except that it has been brought home from Greenland by the missionary Ginge of Godthaab, and that it is said to have been found on the beach. It rather resembles a sample from Kongsberg, and at any rate it has no connection or similarity with the silver from Storø.

3. Gold. *Au.*

The Julianehaab district.

Josva's Copper Mine.

BALL: M. o. G. 63, 1923, p. 37.

Here a few small particles of native gold have been found; they are first mentioned by BALL, who states that they are said to be found

in the uppermost 24 m. In one of the samples of copper ore in the Mineralogical Museum of Copenhagen there are a few tiny grains of gold (the largest ones 0.5 mm).

At no other locality in West Greenland has macroscopically visible gold been found, but it is said to occur in small quantities, both in the pyrite from Ivigtut and in the copper ore from Frederik VII's Mine on Storø. BALL also gives particularly good reasons why there is no chance of finding valuable gold beds in West Greenland.

East Greenland.

EKLUND: Teknisk Tidsskrift, Stockholm, 1944, häfte 14.

This work contains a summary of the gold found in a number of East Greenland occurrences, which have been examined. The amount of gold is always infinitesimal, and the greatest quantity found in any rock in situ is 1.5 gm per ton. A single boulder (the Noe-boulder) was found by NOE-NYGAARD on the Wegeners Halvö, and it contains 5.7 gm per ton.

4. Platinum. *Pt.*

The Umanak district.

Serfat.

SOLE MUNCK: M. o. G. 137, Nr. 5, p. 27.

By spectroscopical examination of a light-coloured quartz-dolerite SVEN PALMQVIST found a very small amount of platinum (less than 0.2 gm per ton); small amounts of Cr, Ni and Cu were also present.

5. Iron. *Fe.*

Both meteoric and telluric iron is found in Greenland, which is the only country in the world containing both kinds in very large quantities. Although it is perhaps not customary to include the constituents of meteorites among the minerals found in a certain country, I consider it natural to do so in this case because of the parallelism.

The Thule district.

The region round Kap York (Ross 1818).

J. Ross: Voyage of Discovery etc. 2, 1819, pp. 121—141. Manual of Greenland p. 324.

SABINE: Quart. Journ. Lit. Sc. 6, 1819, p. 369, and: 7, 1819, pp. 72—94.

Dansk Missionsblad 1844, No. 2, p. 15.
SHEPARD: Am. Journ. Sci. Vol. 42, 1866, p. 249.
STEENSTRUP: M. o. G. 4, 1883, p. 121. Min. Mag., 6, 1884, p. 6.
PEARY: Northward over the Great Ice, vol. 2, p. 552—618, 1898.
WARD: Proc. Rochester Acad., Sc. 4, p. 73.
FARRINGTON: Mem. Nat. Acad. Sci. Wash. 13, 1915, p. 106.
BØGGILD: M. o. G. 74, 1927, p. 11.
PANETH: Zts. Electrochemie, 1928, Nr. 9.
PRIOR: Catalogue of Meteorites in the British Museum, 1923, 1927, 1940.

The blocks of iron are first mentioned by Ross and SABINE, who found the Eskimos in possession of knives consisting of flatly hammered pieces of iron, tied to a handle. When asked about the origin of this iron, the Eskimos answered that it originated from two or more stones, one of them consisting of pure iron, which could not be wrought, whereas the other consisted of stones containing iron globules which they could hammer out for the making of knives. Since then the finding of this iron has been the object of many expeditions. Thus, CHRISTIAN VIII equipped two expeditions, one by dog-sledge and one by boat, but neither yielded any result. On a later occasion the "North Star", one of the vessels in search of FRANKLIN in 1849—50, an English expedition 1875—76, and finally NATHORST in 1883 tried to reach the rocks, but in vain. It was not until 1894—95 that PEARY succeeded in finding the first three blocks which he took to New York.

Altogether five meteorites have been found in the region of Kap York.

1—3 are the iron blocks mentioned above, which by PEARY were called "Ahnighito" (or "tent"), "Woman" and "Dog". PEARY estimates the weight of "Ahnighito" at 100 tons, whereas a later measuring undertaken by WARD gave a result of 46.5 tons, and PRIOR states about 36.5 tons. "Woman" is estimated by PEARY at 3 tons, "Dog" at 0.5 tons.

"Ahnighito" has a very irregular form, one end being rather square and bluff, the other tapering to a point; one side has a massive wedge shape, the other tabular and having a pronounced dorsal fin rising from it. "Woman" has an irregularly rounded form, "Dog" is ellipsoidally rounded. The surface of all three masses has a dark brown colour, interspersed with greenish bits and thus resembling bronze. The etched surface shows characteristic Widmanstätten figures. Although the three blocks resemble each other in almost every particular, "Woman" must have been of a somewhat softer consistency than the others, as it is the only one which the Eskimos have used for the working of small iron tools. Analyses have been made by WHITFIELD (member of the PEARY Expedition) with the following result:

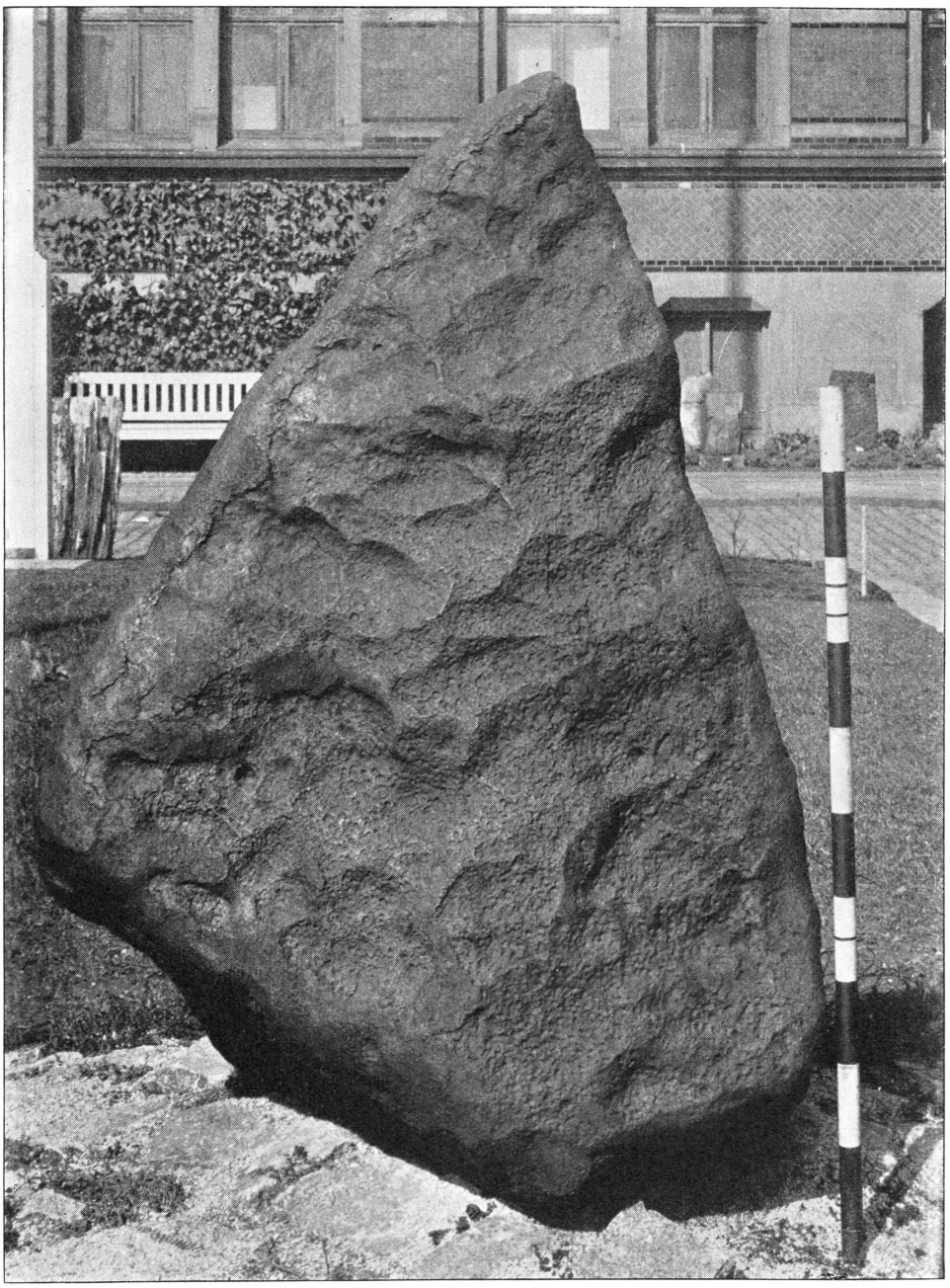


Fig. 2. Meteoric iron. Savik. c. 1:12. (After Bøggild).



Fig. 3. Meteoric iron from Savik; etched plate. 1:1. (After Bøggild).

	Dog	Woman	Ahnighito
Fe	90.993	91.468	91.476
Ni	8.265	7.775	7.785
Co	0.533	0.533	0.533
Cu	0.016	0.018	0.014
S.....	0.019	none	none
P	0.172	0.188	0.202
C	0.014	0.070	0.023

4. The iron from Savik, weight 3.4 tons.

The block was found by KNUD RASMUSSEN in 1913, and was given to the Mineralogical Museum of Copenhagen, which received it in 1925. Its shape is rather that of a pointed triangular pyramid, one side having fairly regular, circular flat depressions, probably a sort of melting phenomenon (fig. 2), while the other sides are very irregular. This block, as may be expected, agrees in all respects with the preceding ones. They all belong to the group "Medium octahedrites" (fig. 3); as to foreign substances the Savik block contains a rather large quantity of troilite (in all about 0.65 per cent.) in addition to innumerable very small rhabdites and a small quantity of chromite. PEARY writes that in the plates wrought from his material there was not "so much as a single gram of any foreign substance". There is no doubt that they exist, and it must be regarded as a peculiar coincidence that they are not present or have been identified in the material at hand.

The analysis of the Savik block was undertaken by F. KRISTENSEN, with the following result: Fe not determ., Ni 7.25, Cr trace, Co 0.000, Cu 0.000, S 0.022, P 0.166; the Co-determination has later on been proved to be wrong, the quantity of Co in Savik being similar to that contained in the other blocks. By means of the Helium method PANETH has determined the age of the block at 8.000—35.000 years, which seems incredibly little and is far below the ages of other meteorites, estimated at several millions of years.

5. A fifth iron block was found by the Eskimos in 1928, and in 1929 it was given by KNUD RASMUSSEN to the Mineralogical Museum of Copenhagen. On the label is written Northumberland, which presumably must be Northumberland Ø (Kiatak), situated far to the northwest of Thule and about 200 km from Kap York, whereas the distance between the other occurrences is at most 13 km. The block is very insignificant compared with the other four, the weight being 292 gm and the greatest diameter a little more than 6 cm. The form must be described as somewhat faceted, but quite irregular (fig. 4). The surface is covered with a black coating of oxide of varying thickness, and there are also fissures in the iron filled with the same black mass. A small slice, which was polished and etched,

showed exactly the same figures as the Savik meteorite. It is impossible to say for certain whether the meteorite in question originates from the same fall as those from the region of Kap York, but there seems to be a possibility that the natives have transported the

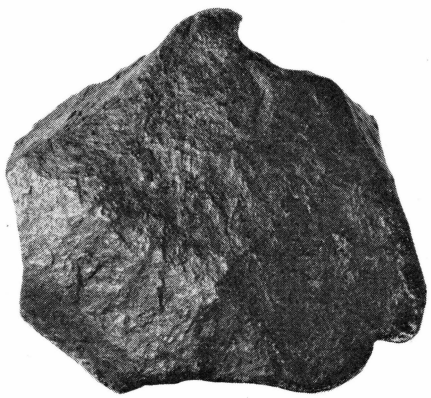


Fig. 4. Meteoric iron, Northumberland Ø. 1:1.

specimen from more southerly regions; at any rate, the continuous crust excludes its having been directly broken off from the other blocks.

The Umanak district.

Eqaluit (Steenstrup 1879).

Steenstrup: M. o. G. 4, 1883, p. 121. Mineralog. Mag. Vol. 6, 1884, p. 6.

Lorenzen: ibid. p. 156. Mineralog. Mag. Vol. 6, 1884, p. 29.

In an old Greenland tomb were found nine pieces of basalt with spheres and irregular patches of iron, as well as iron knives resembling those brought home by Ross. The basalt is typical, coarse-grained, the iron is soft, with a great power of resistance against weathering. Analysis (Lorenzen): Cu 0.23, Fe 94.11, Ni 2.85, Co 1.07 insol. 0.61 = 98.87. Both the occurrence and the analysis show that the iron must be telluric, and that it probably originates from Uivfaq. This also applies to all other occurrences of iron in secondary deposits.

Nûk (Steenstrup).

Steenstrup: M. o. G. 4, 1883, p. 130. Mineralog. Mag. Vol. 6, 1884, p. 12.

Found as microscopical grains in graphite basalt.

Qaersut.

Phalen: Smith. Misc. Coll. 45, 1903, p. 198.

From this locality there is a description of a basalt with uncommonly numerous iron grains up to 15 mm in diameter. The form of

the grains is irregular, and in the interior they enclose numerous basalt particles. Spots, some dim and some shiny, but with sharp, irregular boundaries, are formed by etching. Nothing is said of anorthite or the other minerals which are generally associated with the Greenland iron.

The Ritenbenk district.

Arveprinsens Ejland (GIESECKE).

STEENSTRUP: M. o. G. 4, 1883, p. 122. Mineralog. Mag. Vol. 6, 1884, p. 6.

LORENZEN: ibid. p. 149. Mineralog. Mag. Vol. 6, 1884, p. 24.

In GIESECKE's hand-written catalogue the iron is said to have been found in a peat bog. Weight 410 gm. The surface full of pits like finger-prints. No regular figures when etched. The outer part ductile, the inner part brittle. In the analysis by LORENZEN the determination of C is made on the interior, the others on the outer part: Cu 0.06, Fe 95.67, Co trace, S 0.09, C 1.94, SiO_2 1.40 insol. 1.09 = 100.25. The absence of Ni and Co possibly point towards a European origin; however, the analysis of iron from Asuk shows that also the Greenland iron sometimes contains very small quantities of these metals.

Kûgánguaq (STEENSTRUP 1898).

STEENSTRUP: M. o. G. 24, 1901, p. 274, 276.

Here an iron-bearing basalt was found in a bed about 20 m thick. The structure rather like that of the rock from Mellemfjord.

Asuk (STEENSTRUP 1872 and 1880).

STEENSTRUP: Vid. Medd. Nat. Foren. 1875, p. 295. Mineralog. Mag. Vol. 1, 1877, p. 145.

TÖRNEBOHM: Bih. Vet.-Akad. Hand. Stockh., 5, Nr. 10, 1878, p. 18.

STEENSTRUP: M. o. G. 4, 1883, p. 123. Mineral. Mag. Vol. 6, 1884, p. 7.

TH. NICOLAU: M. o. G. 24, 1901, p. 237.

The iron has been found in situ in a light, greyish, very fine-grained rock, which, on account of its high silica percentage (about 56 per cent), occupies an intermediate position between basalt and diorite; it contains phenocrysts of enstatite. The iron is found in grains varying from a microscopical size to 18 mm; it is silver-white, very soft and ductile. The specific gravity is 7.26. Analysis undertaken by LORENZEN: Cu 0.14, Fe 95.15, Ni 0.34, Co 0.06, C 0.96, SiO_2 0.68, Al_2O_3 0.51, insol. 1.90 = 99.74. The iron from Asuk is historically important as the first to be found outside Uivfaq, thus finally establishing the terrestrial origin of basaltic iron.

Ritenbenk Coal Mine (STEENSTRUP 1898).

STEENSTRUP: M. o. G. 24, 1901, p. 268.

This occurrence is in all respects like the preceding one.

The Godhavn district.

Fortunebay (the physician RUDOLPH 1852).

FORCHHAMMER: Forh. 7. Skand. Naturforskermøde, 1856, p. 152.

RINK: Gr. II, App. p. 151.

FORCHHAMMER: Overs. Vid. Selsk. Forh. 1860, p. 122.

ETZEL: Zts. Ges. Erdkunde, Berlin 11, 1861, p. 479.

LORENZEN: M. o. G. 4, 1883, p. 152. Mineralog. Mag. Vol. 6, 1884, p. 27.

A loose block of iron without adhering rock and weighing about 12 kg. The iron is hard and rather brittle; when etched, it only shows indistinct figures. Analysis undertaken by LORENZEN: Cu 0.20, Fe 92.68, Ni 2.54, Co 0.58, S 0.01, C 2.40, SiO_2 0.31, insol. 0.08 = 98.80. In composition it corresponds exactly with the iron from Uivfaq, from where it probably originates. FORCHHAMMER was of the opinion that this iron, like that from Niaqornaq, was connected with a fall of meteorites at Jakobshavn, which will be mentioned later on.

Uivfaq (Uifak, Ovifak). (NORDENSKIÖLD 1870).

NORDENSKIÖLD: Öfvers. Vet.-Akad. Förh. Stockholm, 27, 1870, p. 973. Geol. Mag. 9, 1872, pp. 289, 355, 409, 449, 516. Miner. Mitth. Wien, 1871, p. 109. Bonn. Sitz.-Ber. Niederrhein. Gesell. 1871, p. 128. Zts. D. Geol. Gesell. 23, 1871, p. 738.

FORBES: Abstr. Proc. Geol. Soc. Nr. 238, 1871.

NORDENSKIÖLD: Öfvers. Vet.-Akad. Förh. Stockholm, 28, 1871, p. 1. Tidss. Pop. Fremst. Naturv. 1872, p. 264.

NORDSTRÖM: Dagens Nyheter, Stockholm, 27. Okt. 1871.

NORDSTRÖM: Öfvers. Vet.-Akad. Förh. Stockholm, 28, 1871, p. 453. Bull. Soc. Chim. Paris, 17, 1872, p. 450.

G. v. RATH: Bonn. Sitz. Ber. Niederrh. Gesell. 28, 1871, p. 128.

NORDENSKIÖLD: Post- och Inrikes Tidningar, Stockholm, 2. Nov. 1871. Abstr. Proc. Geol. Soc., 20. Dec. 1871. Quart. Journ. Geol. Soc. 28, 1872, p. 44. Revue scientifique, 3, 1872, 9, p. 128.

STEENSTRUP: Vid. Medd. Nat. Foren. 1872.

DAUBRÉE: Compt. Rend. Paris, 74, 1872, p. 541, and 75, 1872, p. 240. N. Jahrb. Min. 1873, p. 97.

LUDWIG: Min. Mitt. Wien, 1871, p. 109.

HEBERT: Séance Soc. Géol. de France, 5. Febr. 1872. Revue Scientifique, 1, p. 858.

É. DE CHANCOURTOIS et M. JENNATEZ: Séance Soc. Géol. de France, 19. Febr. 1872. Revue Scientifique, 1, p. 905.

É. DE CHANCOURTOIS: Bull. Soc. Géol. de France, 29, 1872, p. 175 and 210.

DAUBRÉE: Séance Soc. Géol. de France, 20. Maj 1872. Revue scientifique, 1, p. 1169. Amer. Journ. Sci. 3, 1872, p. 71 and 388.

Wöhler: Nachr. Ges. Wiss. Göttingen, 1872, p. 197 and 499. Annal. Chem. Pharm. 163, 1872, p. 147, 165; 1873, p. 313. Pogg. Annal. 146, 1872, p. 297. N. Jahrb. Min. 1872, p. 531. Zts. Gesammt. Naturw. Halle, 41, 1873, p. 102.

G. Rose: Zeits. D. Geol. Gesell. 24, 1872, p. 174.

G. V. Helmersen: Zeits. D. Geol. Gesell. 25, 1873, p. 347.

Blomstrand: Ber. D. Chem. Gesell. 4, 1871, p. 987.

Nauckhoff: Bihang Vet.-Akad. Handl. Stockholm, 1, 1872, Nr. 6. Ber. D. Chem. Gesell. 6, 1873, p. 1463. Min. Mitth. Wien, 1874, p. 109. Lotus, Prag, 23, 1873, p. 223.

Tschermak: Jahrb. Geol. Reichsanst. Wien, 24, 1874, Nr. 2. Min. Mitth. Wien, 1874, p. 165. Der Naturforscher, 1874, Nr. 49—52.

Lawr. Smith: Compt. Rend. Paris, 80, 1875, p. 301.

Flight: Geol. Mag. Dek. II, 2, 1875, pp. 115, 152. Manual of Greenland, p. 447.

G. v. Rath: Ber. Niederrh. Gesell. Bonn. 32, 1875, p. 201.

Rammelsberg: Zts. D. Geol. Gesell. 28, 1876, p. 225.

Steenstrup: Vid. Medd. Nat. Foren. 1875, p. 284. Zts. D. G. Ges. 1876, p. 225. N. Jahrb. Min. 1877, p. 91. Min. Magaz. I, 1877, p. 143.

Daubrée: Compt. Rend. Paris, 84, 1877, p. 66. Bull. Soc. Géol. de France, 5, 1877, p. 111.

Lawr. Smith: Bull. Soc. Min. de France, 1, 1878. N. Jahrb. Min. 1879, p. 625. Annal. Chim. Phys. 5. série, 16, 1879.

Törnebohm: Bihang Vet.-Akad. Handl. Stockholm, 5, 1878, Nr. 10.

Nathorst: Geol. Fören. Förh. Stockholm, 4, 1879, p. 203. N. Jahrb. Min. 1880, p. 214.

Wöhler: N. Jahrb. Min. 1879, p. 832.

Meunier: Compt. Rend. Paris, 1879, p. 924. N. Jahrb. Min. 1880, p. 47.

Faber: Tidss. Naturv. 1880, p. 292.

Steenstrup: M. o. G. 4, 1883, p. 113. Mineralog. Mag. Vol. 6, 1884, p. 1.

Lorenzen: ibid. p. 133. Mineralog. Mag. Vol. 6, 1884, p. 14.

Nordenskiöld: Studier och Forskningar föranledda av mina Resor i Höga Norden, Stockholm, 1884, p. 209.

Brezina: Jahrb. d. k. k. geol. Reichsanstalt, Wien, 35, 1885, p. 201.

Neumayr: Erdgeschichte, 1, 1890, p. 116.

Moissan: Compt. Rend. Paris, 116, 1893, p. 1269.

Nathorst: Jordens Historia, 1, 1894, p. 127.

Brezina: Ann. d. k. k. Hofmuseums, Wien, 10, 1895, p. 297.

Cohen: Ann. d. k. k. Hofmuseums, Wien, 11, 1897, p. 58.

Nicolau: M. o. G. 24, 1901, p. 215.

Winkler: Öfvers. Vet.-Akad. Förh. Stockholm, 7, 1901, p. 495.

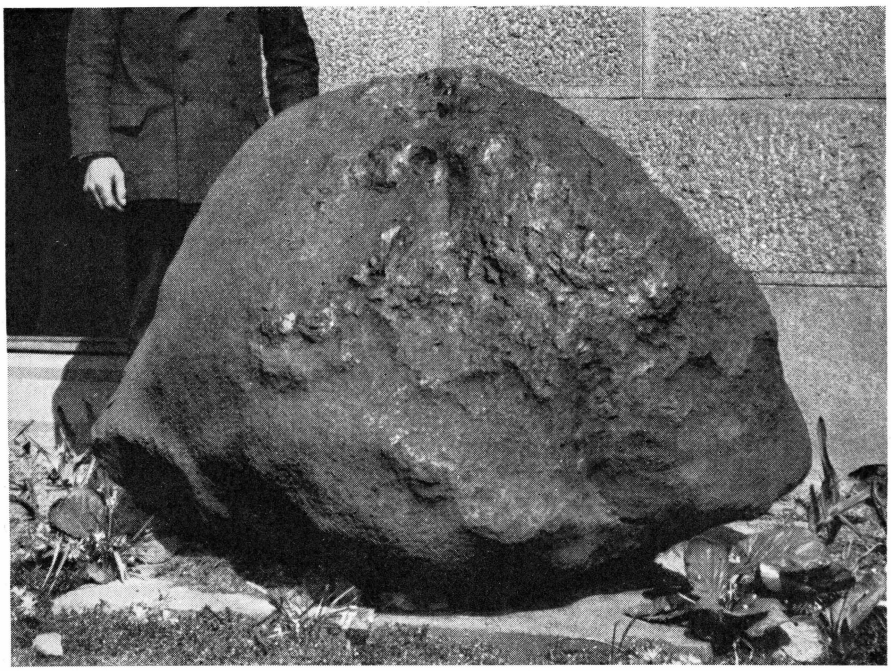


Fig. 5. Iron, Uivfaq. R. WIEGHORST phot. 1:15.

NORDENSKIÖLD: ib. p. 505.

SCHWANTKE: Sitzber. d. k. Pr. Akad. d. Wiss. Sitz. d. phys.-math. Classe v. 6. Dec. 1906.

BENEDICKS: Jernkontorets Annaler för 1910, Stockholm, 1911. Congr. géol. intern. Stockholm, Compte Rend. 1912, p. 885.

NAUCKHOFF: Svensk kem. Tidss. Stockholm, 1916, p. 102.

SJÖGREN: K. Sv. Vet.-Akad. Årsbok för År 1916, p. 255.

PANETH: Zts. Elektrochemie, 1928, Nr. 9, p. 646.

CARPENTER, H.: Nature, London, 136, 1935, p. 152.

LÖFQUIST and BENEDICKS: Jernkontorets Annaler, Stockholm, 1940, p. 633.

HØEG: Naturens Verden, 29, 1945, p. 147.

The occurrence at Uivfaq is particularly characteristic on account of the great quantities of iron found there, and because of the discussion concerning the origin of these masses, which composes the greater part of the literature quoted above. Some of the iron is embedded in a black basalt, which is sometimes microcrystalline or very fine-grained, sometimes more coarse-grained and doleritic, with rather sharp boundaries between the two varieties. Whereas NORDENSKIÖLD originally regarded the ferriferous basalt as a dyke, STEENSTRUP, on the other hand, stated that it constitutes a flow. Sometimes the iron appears as small micro-

scopical or nearly microscopical particles, either more or less rounded, or in thin flakes, and sometimes infilling hairs-breadth fissures. In association with the iron there are here, as in the other localities, characteristic segregations of minerals in the basalt, these minerals being hisingerite, cohenite, pyrrhotite, schreibersite, and also aggregates of anorthite with graphite and spinel. From such a basalt there is every possible stage of transition to types in which the iron predominates over the groundmass, and from there to specimens consisting of nearly pure iron. Native iron is found in great quantities in the large boulders on the beach, which have probably been eroded from the basalt.

The largest of these blocks have the following weights: 25 tons (in Riksmuseet, Stockholm), 6.5 tons (in the Mineralogical Museum of Copenhagen, fig. 5), 4.09 tons (in Helsingfors); furthermore a great number of blocks weighing less than one ton. The blocks are more or less rounded, but irregular, and naturally without the melting phenomena which as a rule characterize meteoric iron, and which also appear, though rather faintly, in the block from Savik at Kap York.

By far the greater part of the iron is rather dark, hard cast-iron; non-carboniferous iron is of very rare occurrence (analysis No. 13). The greater part of the iron disintegrates quickly indoors, whereas it has great power of resistance in the open air; some varieties, however, also are stable indoors. Some of the blocks, when etched with nitric acid, show figures which may be linear, but are generally rather irregular, thus bearing very little resemblance to Widmanstätten figures.

As it will appear from the individual analyses, it has at least in three cases been possible to show that the central parts of the blocks are fairly incoherent and traversed by numerous fissures, for which reason these parts disintegrate rather quickly when exposed to the atmosphere.

Analyses.

1. One of the big blocks (Nordenskiöld). Fe 84.49, Ni 2.48, Co 0.07, Cu 0.27, S 1.52, P 0.20, C 10.16 (incl. O, H_2O and organic ingredients), SiO_2 tr., insol. in HCl 0.05, Cl 0.72, Al_2O_3 tr., MgO 0.04, CaO tr., Na_2O tr., K_2O tr. = 100.00.

2. One of the smaller blocks (Nordström in Nordenskiöld). Fe 86.34, Ni 1.64, Co 0.35, Cu 0.19, S 0.22, C 3.71, P 0.07, SiO_2 0.66, insol. 4.37, Cl 1.16, Al_2O_5 0.24, MgO 0.29, CaO 0.48, Na_2O 0.14, K_2O 0.07 = 99.93. Sp. g. 7.06—6.

3. Iron from the vein (Lindström in Nordenskiöld). Fe 93.24, Ni 1.24, Co 0.56, Cu 0.19, S 1.21, P 0.03, C 2.37, insol. (incl. SiO_2) 0.59, Cl 0.16, MgO tr., Na_2O 0.12, K_2O 0.08, H 0.07 = 99.79. Sp. g. 6.24.

4. A 1 kg heavy sample (Jannasch in Wöhler). Fe 80.64, Ni 1.19, Co 0.47, Cu tr., S 2.82, P 0.15, C 3.69, Cr tr., SiO_2 0.08, O 11.09 = 100.05.

Sp. g. 5.82, comparatively small in agreement with the rather large amount of iron oxide.

5. (Daubrée). Fe, free, 40.94, Fe, combined with O, S and P, 30.15, C, free, 1.64, C combined 3,00, Ni 2.65, Co 0.91, S as sulphides 2.70, As 0.41, P 0.21, Si 0.075, N 0.004, O 12.10, H_2O 2.86, $CaSO_4$ 1.288, $CaCl_2$ 0.039, $FeCl_2$ 0.027, Cr. Cu and loss 1.01 = 100.0.

6. (Daubrée). Fe, free, 80.8, Fe, combined, 1.6, C, free, 0.3, C, combined, 2.6, Si 0.291, H_2O 0.7.

7. (Daubrée). Fe, free, 61.99, Fe, combined, 8.11, C, free, 1.1, C, combined, 3.6.

8. (Nauckhoff). Fe 58.25, Ni 2.16, Co 0.30, Cu 0.13, $FeO.Fe_2O_3$ 30.42, NiO + CoO 0.44, Al_2O_3 1.45, MgO 0.33, CaO 0.50, Na_2O 0.09, SiO_2 0.26, S 0.16, Cl 0.16, C 1.64, H 0.28, insol. 6.07 = 102.64.

9. (Nauckhoff). Fe 28.36, Ni 1.22, Co 0.30, Cu 0.08, $FeO.Fe_2O_3$ 52.51, NiO 0.94, CoO 0.23, Al_2O_3 2.31, MgO 0.02, CaO 0.30, Na_2O 0.08, SiO_2 1.04, S 0.34, P_2O_5 0.12, C 3.52, H 0.38, insol. 9.64 = 101.39. Sp. g. 4.56; this insignificant value is presumably due to the porosity of the material.

10. (Nauckhoff). Fe 7.73, Ni 1.81, Co 0.33, Cu 0.30, $FeO.Fe_2O_3$ 77.39, NiO + CoO 0.82, Al_2O_3 2.92, CaO 0.20, Na_2O 0.11, SiO_2 0.81, P_2O_5 0.12, Cl 0.14, C 2.33, H 0.51, insol. 3.71 = 99.23. Sp. g. is recorded as 6.57, a strikingly high percentage for a substance, which mainly consists of magnetite.

11. (Lawr. Smith). Ferric oxides 76.21, Fe 16.56, Ni 1.08, Co 0.48, Cu 0.08, S 1.12, P 0.14, C 1.36, H_2O 4.50 = 101.53. Sp. g. 5. This analysis represents the outer firm crust of a block of 5 kg.

12. (Lawr. Smith). Fe 93.16, Ni 2.01, Co 0.80, Cu 0.12, P 0.32, S 0.41, Cl 0.02, C combined 2.34 = 99.18. Sp. g. 6.42. This analysis has been undertaken on quite small particles of iron, isolated from the inner loose mass of the same block.

13. (Lawr. Smith) Fe 90.17, Ni 6.50, Co 0.79, Cu 0.13, SiO_2 1.54 = 99.13. Sp. g. 7.46. The analysis is undertaken on small particles from the dolerite, as far as possible freed from the enclosing silicates. The absence of carbon is striking, and so the similarity with meteoric iron becomes very great, but owing to the paucity of the material L. S. does not consider this determination quite accurate.

14. (Lawr. Smith). Fe 88.13, Ni 2.13, Co 1.07, Cu 0.48, P 0.25, S 0.36, Cl 0.08, silicates 4.20, C combined 2.33 = 99.03. Sp. g. 6.80. The material consists of small plate-shaped iron masses in the dolerite.

15. (Lorenzen). Fe 91.71, Ni 1.74, Co 0.53, Cu 0.16, S 0.10, C 1.37, SiO_2 0.31, Al_2O_3 1.21, insol. 2.39 = 99.52. Sp. g. 6.87. The material consists of a rather large block, very fresh.

16. (Lorenzen). Fe 91.17, Ni 1.82, Cu 0.16, Co 0.51, S 0.78, C 1.70,

SiO_2 0.46, Al_2O_3 2.12, insol. 0.77 = 99.49. From a plate-shaped mass, for the greater part quite fresh.

17. (Lorenzen). Fe 82.02, Ni 1.39, Co 0.76, Cu 0.19, S 0.08, C 1.27, SiO_2 0.59, Al_2O_3 1.08, insol. 8.03.

18. (Lorenzen). Fe 59.77, Ni 1.60, Co 0.39, Cu 0.23, S ?, C 1.20, SiO_2 0.39, Al_2O_3 3.79, insol. 22.23. The analyses 17 and 18 originate from the same block; No. 18 represents the central disintegrated part, No. 17 the outer fresh one; no distinction is made between metallic iron and oxides of iron.

19. (Carpenter). Fe 93.9, Ni 2.50, Co 0.98, Cu 0.21, C 1.63, SiO_2 0.24 = 99.46.

20. (Blix, Treje and Hellbom (in Löfquist and Benedicks). Fe 91.61, Ni 1.87, C 3.48, S 1.07, O 1.83, H 0.04, N 0.00 = 99.90.

21. (ibid.). Fe 91.63, Ni 1.78, C 3.59, S 1.14, O 0.93, H 0.02, N 0.05 = 99.14.

22. (ibid.). Fe 91.50, Ni 1.76, C 3.56, S 1.04, O 1.02, H 0.02, N 0.05 = 98.95.

23. (ibid.). Fe 91.58, Ni 1.82, C 3.57, S 1.09, O 0.96, H 0.01, N 0.04 = 99.07.

24. (ibid.). Fe 91.72, Ni 1.84, C 3.92, S 1.09, O 1.99, H 0.18, N 0.20 = 100.94.

The five last analyses have been undertaken on a core, about 188.5 cm in length, through the large Stockholm block; the samples were taken at equal distances, Nos. 18 and 22 representing the outer part, No. 20 the central part. As it will appear, the difference in composition is very slight. The central part of the block was much more penetrated by fissures than the outer part. It is worthy of mention that the block in question differs from all other analyzed Greenland iron in not containing copper and cobalt.

Finally, mention is to be made of an analysis by Iwanoff (in Winkler) which, owing to the whole arrangement, cannot easily be compared with the other ones; he distinguishes between 1: in aqueous solution 2.03 (Fe 0.57, Na 0.18, K 0.11, Mg 0.01, Cl 0.68, SO_3 0.47, O 0.01); 2: in acid solution 89.03 (Fe 75.34, Ni 1.85, Co 0.48, Cu 0.13, C 2.29, S 0.18, Ca 0.07, Mg 0.04, Cl 0.96, SO_3 0.06, O 4.42, H_2O 3.21. and 3: Insoluble 8.96. On the strength of these a great number of complicated combinations are computed, which seem very doubtful and therefore cannot be rendered here.

Owing to the amount of nickel contained in the iron and the structure produced by etching Nordenskiöld supposed the iron to be meteoric iron, and having observed that it was also to be found in the basalt, he put forth the theory that it had fallen, while the basalt was still in a fluid state. Nordenskiöld's view was the prevailing one, until by means of his local investigations of the manner of occurrence

of the iron STEENSTRUP proved that it could not possibly be meteoric. This has since then been the universally recognized opinion, with the exception that NORDENSKIÖLD in 1884 set forth the theory that both basalt and iron should be formed of dust, which theory he modified in 1901, in so far as he then held the opinion that the iron found in cavities in the basalt is formed secondarily by iron carbonyl emanations.

As to the mode of formation of the iron many theories have been set forth. MOISSAN and NEUMAYR are of opinion that it must have been carried with basalt from the depths and so presents a picture of the consistency of the interior of the earth; this is partly contested by the great weight of the iron, partly by the constant association of graphite with iron, which cannot very well be explained in this manner. As demonstrated by STEENSTRUP, it is possible to overcome the difficulty of the specific gravity by supposing that the basalt was viscous when it emerged; in any case the same difficulty applies to the pyrrhotite at Igdlukúnguaq, which will be mentioned later, and for which it is hardly possible to imagine any other mode of formation. LAWR. SMITH and others are of the opinion that the iron compounds of the basalt are reduced by penetration of the coal beds below the basalt formation, while NATHORST is of opinion that the iron originates from the clay-ironstone found in the coals. SCHWANTKE is of the opinion that the iron is produced by the reduction of olivine by means of coal; his starting point is the observation that this mineral is generally wanting in basalt in the vicinity of the iron.

The first micrographic investigations of the iron were undertaken by BENEDICKS, and he found exactly the same structure as in common steel, that is, cementite and pearlite, the latter being a mixture of cementite and ferrite; he proved the existence of a hitherto unknown constituent, oxidepearlite, which is a mixture of cementite and oxide of iron. As the mode of formation he imagines a reduction of the iron compounds in the basalt by coal. LÖFQUIST and BENEDICKS carried out further metallographic investigations; besides the constituents mentioned troilite, schreibersite, and pentlandite occur as secondary constituents, bravoite (a pyrite containing nickel), nifesite (an aggregate of pentlandite and bravoite), göthite (probably the iron oxide contained in the oxidepearlite) and hisingerite. The probable mode of formation is said to be the following: one of the larger blocks of pyrrhotite containing nickel has penetrated into a fissure in the country rock, through which fissure the basalt has later risen. The basalt before emerging has absorbed coal by passing through coal beds.

A description of the structure with many illustrations is given by HØEG.

By means of the helium method PANETH has determined the age of the iron as 32 million years.

A rather complete survey of all conditions relating to the iron from Uivfaq has been given by SJÖGREN.

Telluric iron has later been found in many localities, more particularly in fairly large quantities at Weimar.

Ivisârqut in Mellemfjord (STEENSTRUP 1880).

STEENSTRUP: M. o. G. 4, 1883, p. 127. Mineralog. Mag. Vol. 6, 1884, p. 10.

NICOLAU: M. o. G. 24, 1901, p. 242.

Small grains in a rock which bears an outward resemblance to basalt, but according to the analysis rather seems to be andesite. In 1902 PORSILD found in this locality a fairly large block of iron (cross-section 7 cm); it is very impure as the iron constitutes the smaller part and is distributed in irregularly shaped, somewhat branching small particles scattered among the other constituents. When etched, the iron shows small curved, shining lines at the boundary with the surrounding rock.

The inner part of Mellemfjord (STEENSTRUP 1880).

STEENSTRUP: M. o. G. 4, 1883, p. 126. Mineralog. Mag. Vol. 6, 1884, p. 10.

LORENZEN: ibid. p. 144. Mineralog. Mag. Vol. 6, 1884, p. 21.

The iron has either separated out in the basalt itself, or, together with pyrrhotite, fills vesicular cavities mostly of pea-size. The iron is silver-white, soft and extremely ductile; when etched, it shows very fine figures. Specific gravity 7.48—7.92. Analysis by LORENZEN: Cu 0.33, Fe 93.89, Ni 2.55, Co 0.54, S 0.20, C 0.28, SiO_2 0.46, insol. 1.48 = 99.73.

Jernpynten (STEENSTRUP 1880).

STEENSTRUP: M. o. G. 4, 1883, p. 125. Mineralog. Mag. Vol. 6, 1884, p. 9.

LORENZEN: ibid. p. 146. Mineralog. Mag. Vol. 6, 1884, p. 22.

NICOLAU: M. o. G. 24, 1901, p. 241.

The occurrence nearly like the preceding one, the iron only not being quite so ductile. Specific gravity 6.90—7.57. Analysis undertaken by LORENZEN: Cu 0.48, Fe 92.41, Ni 0.45, Co 0.18, S trace, C 0.87, SiO_2 0.90, Al_2O_3 0.60, insol. 4.57 = 100.46.

The Jakobshavn district.

Niaqornaq (RINK 1848—50).

RINK: Ngr. p. 61.

FORCHHAMMER: Overs. Vid. Selsk. Forh. 1854, p. 1.

FORCHHAMMER: Skand. Naturf. 7. Møde, 1856, p. 152.

RINK: Gr. 1, p. 184.

LAWR. SMITH: Annal. Chim. Phys. 16, 1879.

LORENZEN: M. o. G. 4, 1883, p. 150. Mineralog. Mag. Vol. 6, 1884, p. 25.

COHEN: M. o. G. 15, 1898, p. 291.

A lump of iron weighing 10.5 kg was found by a Greenlander on a stony flat by the river Anoritôq. It had very small adherent fragments of basalt and in all probability originated from Uivfaq. The iron is very hard, and granular and consists of a mixture of iron and cohenite. When etched, it shows irregular figures. Specific gravity 7.00—7.60. Analyses undertaken by Forchhammer (1), L. Smith (2), Lorenzen (3) and Sjöström (in Cohen) (4).

	1.	2.	3.	4.
Fe	93,39	92,45	92,46	93.64
Ni	1.56	2.88	1.92	2.00
Co	0.25	0.43	0.93	0.48
Cu	0.45	0.18	0.16	0.07
C	1.69	1.74	3.11	3.72
P	0.18	0.24	0.07	0.19
S	0.67	1.25	0.59	1.13
SiO_2	0.38	1.31	0.24	
insol.			1.09	
	98.57	100.48	100.57	101.23

Probably from the same region is the iron block reported by Steenstrup (Geol. Fören. Förh. Stockholm, 14, 1892, p. 132); according to the register kept at Nepisene by Jacob Geelmeyden, a Dutch skipper in 1729 took an iron block with him to Amsterdam, the block being so large that twenty men could only with difficulty get it on board. It was shaped like a ball, as hard as the hardest steel and very shiny. In the following year the locality was carefully searched, but it was not possible to find more iron, neither has it been possible in more recent times to find this iron block in Holland. The account is of interest because it is the first time that mention is made of Greenland iron.

Jakobshavn (Pfaff).

Nordenskiöld: Öfvers. Vet.-Akad. Förh. Stockh. 1890, p. 1069.

The iron which Pfaff gave to Öberg in Stockholm weighs very nearly 4 kg. It is very hard, granular and mixed with considerable quantities of a mass resembling basalt. When etched, it shows a crystalline structure.

As to the supposed find of a meteoric stone at Jakobshavn, P. Egede (Efterretning om Grønland, p. 247) reports that one night in the winter of 1740—41 a sound like thunder was heard, and that on the following day a stone was found there as large as a house. Giesecke (in Chaldni: Feuer-Meteore, 1819, p. 243) reports that it was not a meteoric stone, but an ordinary greenstone which had fallen down from the mountain. Forchhammer (Skand. Naturf. 7. Møde, 1856, p. 152) nevertheless connects the iron from Fortunebay and Niaqornaq with this fall.

Sermermiut.

LORENZEN: M. o. G. 4, 1883, p. 158. Mineralog. Mag. Vol. 6, 1884, p. 30.

A Greenland knife has been subjected to a partial analysis: Cu trace, Ni 7.76, Co 0.56. These figures very nearly agree with the usual figures for meteoric iron, but there is also a single analysis of the Uivfaq iron (No. 13), which contains a nearly equally large amount of nickel.

The Egedesminde district.

Hunde (Dog) Ejland.

Together with the preceding, a knife from this region has been analysed: Cu 0.18, Ni + Co 0.23; here there is hardly any doubt that it is Uivfaq iron.

The Godthaab district.

Fiskenæsset (RINK 1853).

FORCHHAMMER: Overs. Vid. Selsk. Forh. 1854, p. 4. — Almenfattelige Naturskildringer, p. 220.

RINK: Gr. II, App. p. 150.

LORENZEN: M. o. G. 4, 1883, p. 154. Mineralog. Mag. Vol. 6, 1884, p. 28.

Two small lumps with a total weight of 153 gm from a doleritic mass in which the iron branches. The iron is extremely ductile; specific gravity 7.06. Analysis by LORENZEN: Cu 0.36, Fe 92.23, Ni 2.73, Co 0.84, C 0.20, SiO_2 0.64, Al_2O_3 0.64, insol. 1.99 = 99.63. The analysis clearly points to Uivfaq iron.

6. Cohenite. *Fe_3C.*

The Godhavn district.

Uivfaq.

TÖRNEBOHM: Bih. Vet.-Akad. Handl. Stockholm, 5, No. 10, 1878.

COHEN: Ann. d. k. k. Hofmuseums, Wien, 12, 1897, Hefte 1, p. 58.

THOMSON, ELLIS: Univ. Toronto Studies, Geol. Ser. 24, 1927, p. 41.

Found as small irregular grains together with iron and the other constituents mentioned in connection with it. The colour is that of faintly tarnished pyrrhotite. Analysis by SJÖSTRÖM (in COHEN): Fe 92.73, Ni 0.95, Co 0.39, C 5.93. THOMSON is of the opinion that some material, which was given to him for examination, consists of a mixture of iron, cohenite and troilite.

The Jakobshavn district.

Niaqornaq.

FORCHHAMMER: Oversigt over Vid. Selsk. Forh. 1854, No. 1.
SHEPARD: Am. Journ. Sci. 43, 1867, p. 28.
COHEN: M. o. G. 15, 1898, p. 291.

The occurrence has been mentioned under iron. The cohenite occurs as slightly coherent aggregates with brightly shining cleavage planes, the colour greyish black. Specific gravity of the pure material 7.5. Analysis undertaken by SJÖSTRÖM (in COHEN): Fe 92.01, Ni 1.13, Co 0.37, C 6.49. FORCHHAMMER, the first to describe an iron carbide, determined the specific gravity at 7.172; in two analyses he found 7.23 and 11.06 C. For this compound he gave the formula Fe_2C, which SHEPARD later named chalypite. It is, however, possible that FORCHHAMMER has analysed a mixture of cohenite and pure carbon.

7. Schreibersite (Rhabdite). $(Fe,Ni,Co)_3P$.

The Thule district.

The region round Kap York.

BØGGILD: M. o. G. 74, 1930, p. 11.

Rhabdite occurs in great quantities as nearly microscopical crystals in the meteorite from SAVIK, and probably also occurs in the other meteorites from this region.

The Godhavn district.

Uivfaq.

TÖRNEBOHM: Bih. Vet.-Akad. Handl. Stockholm, Vol. 5, No. 10, p. 8.
LORENZEN: M. o. G. 4, 1883, p. 137. Mineralog. Mag. Vol. 6, 1884, p. 15.
MOISSAN: Compt. Rend. Paris, 116, 1893, p. 1270.

According to TÖRNEBOHM found in small irregularly shaped or tabular particles together with native iron etc. As it is only determined by means of the colour, its insolubility in hydrochloric acid and its lack of copper coating when treated with a solution of copper sulphate, it may possibly be mistaken for cohenite, which in these respects has the same properties. As, however, phosphorus has been found in many of the iron analyses, and it can hardly be imagined to be present in other compounds, the occurrence of this mineral may nevertheless be regarded as fairly certain, not only in this locality, but also in several of the other occurrences of iron. By a chemical process MOISSAN has isolated small particles of schreibersite.

8. Bismuth. *Bi.*

The Holsteinsborg district.

Kangerdluarssuk.

PAULY: Medd. D. Geol. Foren. 11, 1, 1946, p. 36.

Found as elongated grains (up to a few mm long) of irregular form, together with and enclosed in bismuthinite.

9. Sulphur. *S.*

The Umanak district.

Storöen (?).

RINK: Gr. II, App. p. 152.

To this locality RINK doubtfully refers a conglomerate with sulphur as cement, mentioned by SCHUMACHER[1]) from Greenland. The sulphur is greyish-yellow in colour, opaque, porous and without lustre; it is only slightly coherent. Together with sand and small scattered grains of graphite it cements larger and smaller fragments of white and greyish-white quartz.

Pujortoq (ROSENKRANTZ 1938). A sub-terranean fire in bituminous shales lasting over several years and still burning (1948), has caused the formation of a number of fumaroles, and round these a large number of sublimation products have been deposited. The greater part of these consists of sulphates, particularly aluminium sulphate, but in most cases it is impossible to determine the minerals. Most of them are very alike, and there are hardly any distinct crystal forms; furthermore, as the different minerals are often mixed, a chemical analysis cannot help in their determination. Besides the sulphur only a couple of ammonium compounds can be determined for certain, and these will be mentioned later on.

Sulphur is sometimes found as a thin coating on the sulphates, sometimes also as pure crusts about 1 cm thick. As is frequently the case with sublimation products, it consists of loosely connected crystals, hardly exceeding 1—2 mm in length. The only form observed is (111) which may be well developed with excellently reflecting faces, whereas in other cases skeletal crystals are developed. The colour is light yellow.

The Frederikshaab district.

Ivigtut (GIESECKE 10-8-1809). Here it is mentioned that the galena is sometimes coated with a yellowish crust, which burns with a blue

[1]) Verzeichniss der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 4.

flame and with the smell of sulphur. This mineral has not been mentioned in later reports from Ivigtut.

East Greenland.

Jørgen Brønlunds Fjord (Troelsen 1947).

Troelsen, M.o.G. 149, Nr. 2, 1949, p. 26.

Found as a fine sand or powder between fragments of pyrite in a small crater. The size of the grains is hardly above 0.05 mm; the form is irregularly rounded.

10. Graphite. *C.*

Graphite has been found at a great number of localities in Greenland, mostly as small scales in gneiss or other crystalline rocks, but also frequently under other conditions. The mineral has been in great request, and sometimes mining for it has been commenced, but now it is everywhere abandoned. The Greenland graphite is for the first time mentioned by H. Egede in 1741 (Det gamle Grønlands nye Perlustration) and is described as "something which looks like lead ore". In the following only such occurrences are mentioned, in which the mineral appears in fairly large and striking masses.

The Upernavik district.

Uigordlerssuaq. (Giesecke 23-7-1807). To be found in pegmatite veins in gneiss as irregular tabular crystals and, furthermore, as folia disseminated in the gneiss itself. Sometimes it also occurs in quite a pure form as a finely foliated aggregate.

Langø.

Rink: Ngr. p. 43.

Rink: Gr. I, 1, p. 179.

Krantz: Det grønlandske Selskabs Aarsskrift, 1908, p. 11.

The occurrence which is one of the most considerable in Greenland is to be found on the so-called "Søndre Næs" (Southern Point), but it also extends as far as Upernavik Ø and the intermediate islets. According to Ussing, who visited the locality in 1886, the rock consists of gneiss rich in garnets, with alternating lighter coloured beds, and rusty-brown beds containing pyrite and graphite; the latter may attain a thickness of a couple of metres, but cannot be traced continuously over longer distances. The graphite occurs, either finely scattered in these beds, or in a pure state as irregular veins which may attain a thickness of up to 7 cm. The graphite is associated with iolite.

Rink states that the locality was visited in 1845, first by four vessels, which only brought back a small quantity, and later on by a Mr. Davisson with two vessels, on which occasion about 100 tons of graphite were obtained. The mining was undertaken, partly from the western point of Søndre Næs, very nearly at sea-level, partly

in the interior of the bay bounding this naze towards south, at a height of about 100 m. On a later occasion the mining engineer, EINAR KRANTZ, has undertaken a thorough investigation of this locality; he arrives at the conclusion that the ore is of too poor a quality to pay for mining.

The Umanak district.

Kugssineq (Kook) angnertuneq.

STEENSTRUP: M. o. G. 4, 1883, p. 130. Mineralog. Mag. Vol. 6, 1884, p. 12.

Found as rounded lumps in a basalt dyke.

Marmorilik (NOE-NYGAARD 1939). Thin bands containing graphite in the marble. The graphite forms small spherical bodies a few mm in size and of microcrystalline structure.

Storøen (GIESECKE 24-4-1811).

RINK: Ngr. p. 46.

RINK: Gr. I, 1, p. 179.

Small flakes (up to 1 cm) of indistinct outline in a mica-schist consisting of biotite, quartz and garnet; also to be found as thin layers in the mica-schist.

Qaersut (RINK 1848).

RINK: Ngr. p. 51.

RINK: Om Monopolhandelen paa Grønland, 1852, p. 93.

LUNDT: Nogle faktiske Oplysninger i Anledning af Planen til Bjergværksdrift paa Grønland, 1853, p. 5.

TAYLER Pet. Mitt. 1856, p. 118: Expedition nach Grönland zur Anlage und Betrieb des Bergbaues.

RINK: Gr. I, 1, p. 181.

NORDENSKIÖLD: Öfversigt Vet.-Akad. Förh. Stockholm, 1870, 27, p. 1042.

R. BROWN: Transact. Geol. Soc. Glasg. 5, 1875. — Manual of Greenland.

STEENSTRUP: M. o. G. 5, 1883, p. 56.

LUZI: Zts. f. Naturw. Halle, 64, 1891, p. 224.

MOISSAN: Compt. rend. 121, p. 540.

Partly found as impregnation in shale and sandstone, partly as a single bed at a height above sea-level of 320—380 m. Very fine and microcrystalline with a shining surface; probably produced by the contact metamorphism of a coal-bed. The thickness of the bed up to 16 cm, the extent up to 2 km; the graphite surrounded by white, hardened sandstone. Specific gravity determined at 1.950, which is uncommonly low for graphite and may indicate an intermixture with coal. LUZI refers the graphite from this locality to the variety graphitite; MOISSAN describes it as very impure.

In 1850 LUNDT excavated 5000 kg, 75 kg of which were sold in the course of the year to England at a price of £ 90; in the following year the price fell so much that the remainder could not be sold, and it is stated that the quality was too poor; since then, this occurrence has yielded no profit.

The neighbouring localities, Østerfjeld, Qaersuarssuk and Slibestensfjeld were investigated by HEIM and RAVN (M. o. G. 47, 1911). The geological conditions are everywhere of such a nature that it may be taken for granted that the transformation of coal to graphite has been caused by the thermal metamorphic effect of adjacent masses of peridotite.

Niaqornat (STEENSTRUP 1878).

STEENSTRUP: M. o. G. 5, 1883, p. 10—11.

Found as contactmetamorphosed bituminous shales. Microcrystalline, with a dull surface. Specific gravity: 2.345, which is probably due to a rather large intermixture of impurities, particularly clay. Like the adjacent unaltered shales they contain calcareous concretions with marine fossils.

The Ritenbenk and Godhavn districts.

Uivfaq, and all the other localities, where native iron has been found in situ.

NAUCKHOFF: Bih. Vet.-Akad. Handl. Stockholm, Vol. 1, No. 6, 1872.

STEENSTRUP: Vid. Medd. Nat. Foren. 1875, p. 294, p. 301. Mineralog. Mag. Vol. 1, p. 144, p. 148.

TÖRNEBOHM: Bih. Vet.-Akad. Handl. Stockh. Vol. 5, No. 10, 1878.

LAWR. SMITH: Ann. Chim. Phys. 1879, 5. Ser., Vol. 16.

STEENSTRUP: M. o. G. 4, 1883, p. 113. Mineralog. Mag. Vol. 6, 1884, p. 1.

LORENZEN: ibid. p. 133. Mineralog. Mag. Vol. 6, 1884, p. 14.

NICOLAU: M. o. G. 24, 1901, p. 233.

Particularly found in anorthite aggregates in the basalt, which are so intermixed with graphite that from a macroscopical point of view they resemble graphite. In one locality (Igdlorpait on the northern side of Disko) PORSILD has found similar aggregates without native iron. In a number of localities the graphite is disseminated in the basalt (graphite basalt) and in one place (Nûk on the Nûgssuaq peninsula) it occurs as small pellets in the basalt.

The Egedesminde district.

This and the following district, more particularly the boundary area between them, viz. the region round Nagssugtôq, seem to be particularly rich in graphite, and many of the samples show large quantities of pure graphite. In

spite of numerous investigations it has, however, not been possible to prove that any of the occurrences are usable for technical purposes.

Sungaussaq (Giesecke 1807). A fine-grained pure sample (diameter about 1 dm) with numerous slickensides. Bernburg's Expedition (1903) found samples of a pure fine-grained graphite at the neighbouring Qeqertarssuatsiaq.

Eqalugssuit (Giesecke 13-6-1808).

Rink: Ngr. p. 46.

Rink: Gr. I, 1, p. 179.

It is stated that graphite is to be found in considerable quantities. The Bernburg Expedition found it partly disseminated in gneiss, partly as veins (up to 2 m); most of these, however, are not particularly rich, and only one contained up to 50 per cent. of graphite. Samples, which were sent to the Mineralogical Museum in Copenhagen by K. Fæster, partly consist of rather irregularly shaped tabular crystals (up to 2 cm) in labradorite, associated with a number of apatite crystals, and partly as large nearly pure masses with a columnar structure.

Nagssugtôq (Rink 1848).

Rink: Ngr. p. 46.

Rink: Gr. I, 1, p. 179.

Is said to be found in considerable quantities; at the western end of the northern bank of the fjord the Bernburg-Expedition states that it found large masses in the steep shore.

The Holsteinsborg district.

Nûgssuaq (Nyeboe). From here a number of samples of more or less pure graphite are at hand.

Súngoq. In 1879 Kornerup, on the top of Súngoq, found a loose block of rather impure graphite with small crystals (diameter 1—2 mm) in cavities: either six- or twelve-sided with indefinite marginal faces. A few larger crystals are distinctly bounded by base and the fundamental rhombohedron. On the eastern side of Súngoq the Bernburg-Expedition found a vein 4 m thick, and several smaller ones of a not particularly pure g. Samples sent by Fæster in 1939 consist of coarse-grained diopside with numerous scales (diam. 2 cm) of graphite, without a regular outline.

Utorqaq. As to a graphite occurrence in this place see Ball (M. o. G. 63, 1923, p. 44).

Suputoq. Here the Bernburg-Expedition in 1903 found a vein 4 m thick in a river bed.

Nipisat Sund. On a smaller island the Bernburg-Expedition

found graphite, partly disseminated in gneiss, partly in greater quantities together with pyrite in veins a couple of metres thick, and partly in association with quartz in veins (a few cm thick) penetrating the rock of in all directions.

The Sukkertoppen district.

Kangâmiut (SØLTOFT 1862). Specimens (up to 40 cm) of columnar graphite without other minerals, apparently unusually pure.

The Frederikshaab district.

Arsuk Ø (RINK 1856).

RINK: Gr. II, p. 150.

From here there are large samples which presumably are part of what USSING called the "Arsuk group". The graphite is very glossy, micro-crystalline with slickensides; it is rather hard, which is due to an intermixture of foreign minerals, including calcite.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 229.

FLINK: M. o. G. 24, 1901, p. 15.

There are two different modes of occurrence, viz. partly as compact masses with felspar and ægirine, up to 1 cm thick, and partly as small crystals associated with elpidite and taeniolite, the outlines of the tabular crystals are irregularly hexagonal; they are thickest in the central part, and no crystal faces have been observed.

Amitsoq. The first mention of graphite is made by A. JESSEN (M. o. G. 16, 1896, p. 139) who writes that at a number of localities in this region there are considerable quantities of impure graphite, the gneiss passing smoothly into a schistose ferruginous graphite, which forms larger or smaller patches in the ordinary gneiss. The samples brought back by JESSEN, which agree very well with some sent at a later period by NYEBOE, prove to be of a very fine-grained rock, which in some cases is regularly schistose. As far as can be estimated, nearly a third consists of graphite, the remainder of quartz with some labradorite and biotite (Fig. 6). After NYEBOE (1911) had found g., a regular mining of this mineral was started, and this lasted until 1925, the total production being about 6000 tons[1]).

Nanortalik.

GIESECKE: Catalogue, p. 201.

[1]) Cf. Ball in M. o. G. 63, 1923, p. 47 and BØGGILD in "Greenland", vol. 3, p. 396. BALL's figures vary somewhat from mine, which originate directly from NYEBOE.



Fig. 6. Graphite ore from Amitsoq. c. 45:1, 1 Nic.

Rink: Gr. II, App. p. 150.

Eberlin: M. o. G. 9, 1889, p. 251.

In thin finely foliated layers in gneiss, sometimes also as large, rather pure masses.

Sigssarigsoq Fjord (Jessen 1894).

Found in greater quantities in pegmatite, frequently preponderating over the other constituents; the consistency slaty or microcrystalline.

East Greenland.

Tiniteqilâq (Kruuse 1901, Rüttel 1902). Large samples of foliated and scaly graphite, together with quartz and a few individuals of actinolite. In cavities it is found as tabular crystals without any regular boundary; in quartz and calcite there are a few, more regular crystals.

Ikerasak north-east of Angmagssalik (Kruuse 1899).

O. Nordenskjöld: M. o. G. 28, 1909, p. 7.

From here are mentioned layers of coarse-grained graphite schist, which in addition to graphite contained biotite, quartz and plagioclase.

II. SULPHIDES AND ARSENIDES

11. Chalcocite. Cu_2S.

C. is found in several localities, more particularly in southern Greenland. With a few exceptions the mineral is accompanied by bornite, which in all its occurrences is associated with chalcocite. As bornite is, as far as can be seen, the chief mineral in most localities, it will be natural to deal with all the occurrences containing both minerals under this mineral. C. without bornite is found in the following localities:

The Christianshaab district.

Claushavn (RINK). Small (up to 1 cm) irregular grains together with chalcopyrite and malachite in quartz.

East Greenland.

Klitdalen (ROSENKRANTZ 1927). In an arkose conglomerate on the most northerly peak but one in "the Ruins" thin (2—3 mm) fissures were found filled with chalcocite and a great amount of malachite.

Fleming Fjord (O. NORDENSKJÖLD 1900). In a quartzite, chalcocite veins (less than 1 mm) were found associated with small quantities of cuprite and malachite.

(Clausthalite and berzelianite).

TAYLER (Addenda to GIESECKE's Catalogue of Minerals. Jour. R. Soc. Dublin, 183, 1860—62, p. 215) mentions these rare minerals (PbSe and Cu_2Se respectively) as being found in the neighbourhood of Godthaab. As nothing is said regarding their determination, and as it is hardly possible to identify them without closer investigations, their occurrence in Greenland must be considered doubtful.

12. Bornite. Cu_5FeS_4.

The occurrence of this mineral together with chalcocite has been mentioned above; in the following all the known occurrences of b. will be mentioned, and they are thus all of them also occurrences of chalcocite.

The Holsteinsborg district.

Kangerdluarssuk (LASSEN 1876).

PAULY: Medd. D. Geol. Foren. 11, 1, p. 36.

K. is a branch of the large Fjord Ikertôq, but as K. is rather large, it will perhaps be very difficult to find the locality, about which nothing is reported. The material consists of a large specimen of granular quartz, and several smaller specimens of copper ore. PAULY has in that ore found different very interesting minerals as bismuth, bismuthinite, luzonite, cosalite (?), besides several minerals which it has not yet been possible to identify. As usual the bornite is accompanied by chalcocite which is found in three or four modifications.

A single sample of a similar nature was handed over to the Mineralogical Museum in 1899 by P. MÜLLER in Holsteinsborg, it possibly dates from the same occurrence.

The Frederikshaab district.

Sánerut (FLINK 1897). A mixture of the two minerals, bornite and chalcocite.

The Julianehaab district.

Josva's Copper Mine.

RINK: Om Monopolhandelen paa Grønland, 1852, p. 95.

LUNDT: Nogle faktiske Oplysninger i Anledning af Planen til Bjergværksdrift paa Grønland, 1853, p. 13.

RINK: Gr. II, p. 133.

HOFF: Om Alderen af de i Grønland forekommende Formationer etc., 1864, p. 11.

BALL: M. o. G. 63, 1923, p. 31.

According to HOFF the ore is found as a layer or a vein in green schist, most likely chlorite-schist. According to a work in manuscript by the mining engineer FRIIS the enclosing rock is mica-schist, and according to BALL it is granite with basic enclosures. There are numerous dykes of diabase, in the neighbourhood of which the separation of the ore is particularly marked. The accounts at hand differ in detail, and it must suffice to refer to BALL who in all probability has made the most thorough examination. The ore at the surface consists of bornite, chalcocite and chalcopyrite, but farther down the chalcocite disappears, and also the quantity of copper on the whole becomes smaller. It is possibly here the lower part of a secondary enrichment, the upper parts of which have been eroded away by the ice. Besides the ores the vein contains a number of other minerals such as epidote, fluorite, quartz,

calcite, actinolite, brown garnet and prehnite. A few small crystals (about 2 mm) have been found, bounded by (100) and (111) and very poorly developed.

The ore was discovered in 1852 by the Greenlander Josva, and as early as July in that year Rink visited the locality and gave it the name it still bears. Together with an assistant he excavated 2000 kg, and in August Friis, who at that time accompanied Lundt on a voyage of inspection in the neighbourhood of the mine, was sent up to it and blasted a boatload of ore. In the summer of 1853 an Englishman, by name Robinson, arrived at the mine after having first examined the native silver on Storø, and the same summer he went away with the ore blasted there (about 20 tons), while the whole of his crew was left behind under the leadership of Friis. They spent an uncommonly severe winter there blasting 30 tons of ore, after which the mine was regarded as exhausted. However, the vessel, which in the summer of 1854 was sent up with provisions and a new house, was wrecked, but in spite of that two workmen were left there for the following winter; another vessel, sent out to fetch the copper ore extracted, suffered shipwreck close to the place.

In 1905 the work at the copper mine was resumed by the "Grønlands Minedrifts-Aktieselskab" after it had been proved by renewed investigations that there was more copper than had formerly been supposed. The workings included an 88 m deep inclined shaft on the vein, about 490 m of drifts and cross-cuts, and about 110 m of shafts and drifts in the adjacent cupriferous schists. The working was again abandoned in 1914, after about 90 tons of copper had been extracted.

Ilímaussaq (Bøggild 1900).

Small quantities in altered diabase together with chalcocite, malachite, brown garnet and mica.

Nunasarnaq (Høeg).

Ball: M. o. G. 63, 1923, p. 34.

Nodular masses of epidote with bornite and chalcocite have been found in altered trachydoleritic lava.

Missame, slightly to the north of Julianehaab. Very small masses together with chalcocite in gneiss.

Kangve (handed in by the Administration of Greenland in 1929); the same combination of minerals, occurring as veins in a red granitic rock.

Frederik VII's Mine on Storø (Qeqertarssuaq). (Giesecke 15-8-1806).

Rink: Om Monopolhandelen paa Grønland, 1852 p. 94.

N. Jahrb. f. Min. 1852, p. 362.

Lundt: Nogle faktiske Oplysninger i Anledning af Planen til Bjergværksdrift paa Grønland, 1853, p. 10.

Tayler: Peterm. Mitt. 1856, p. 118. — Ill. London News (here Storø is erroneously said to be situated south of Arsuk) 1851, No. 783. Litt. Gazette, No. 2039.

Rink: Gr. II, p. 132.

Hoff: Om Alderen af de i Grønland optrædende geologiske Formationer, 1864, p. 14.

Jespersen: Det grønl. Selsk. Aarsskrift, 1914, p. 58.

The occurrence seems to have formed a rather irregularly shaped mass, about 6 m in length and consisting of bornite and chalcocite, as it seems in almost equal quantities, mixed with quartz and enclosed in granite. The b. forms quite irregular masses, which in the existing material attain a size of at most 5 cm.

The outcrop was found by a Greenlander about 1800, and it was with a view to determining the value of the find that Giesecke in 1806 was sent up to Greenland. This journey, on account of the war with England, lasted more than seven years. He observes, however, that the copper does not appear to be workable. Later on (in 1851) Lundt opened up the so-called Frederik VII's Mine which was worked for about six months, after which period the copper was exhausted. The total output amounted to about 15 tons of ore. In 1905 Bernburg began mining in the place, but the attempt must have been given up after quite a short while; the ore was found to contain about 5.4 per cent. Cu, 1 per mille of silver and traces of gold.

East Greenland.

In Petermann's Mitt. 1885, p. 58 it is said that Eberlin was supposed to have found bornite on the east coast of Greenland. Eberlin himself (M. o. G. 9, 1889, p. 255) states that this is due to a mistake arising from a premature report on the minerals found in the course of the expedition.

13. Pentlandite. $(Fe,Ni)_9S_8$.

The Ritenbenk district.

Igdlukúnguaq.

Löfquist and Benedicks: Jernkontorets Ann. Stockh. 1940, p. 660.

Here the authors show that the pyrrhotite is penetrated by quite thin lamellæ of pentlandite, parallel with the base and a prism; they maintain that it is these lamellæ which cause the pronounced cleavage of the pyrrhotite when containing nickel, but not otherwise.

The Godhavn district.

Uivfaq.

Löfquist and Benedicks: l. c.

Also here the mineral is described as occurring in quite thin lamellæ along the base and the prism in the troilite found in this place.

14. Sphalerite. *ZnS.*

The Thule district.

Red Head (Mylius-Erichsen).

Some samples of a fine-grained mixture of s. with pyrite, almost without other minerals. S. is black, and in transmitted light deep red or reddish brown.

The Umanak district.

Marmorilik (Dreyer-Jørgensen and Noe-Nygaard 1939).

Sølver: Ingeniøren 1943, k. p. 61.

Here a remarkable dark bed was observed, being of a winged shape and situated high up in the vertical rock wall on the opposite side of the fiord to the quarry. The place itself was absolutely inaccessible, but the extent of the dark area may be computed at a minimum of 40.000 m². Fallen specimens prove the rock to be a very rich ore; and there is no reason to doubt that they are representative of the whole mass. Sølver's investigations prove the ore to consist of a mixture of the following minerals: pyrite, sphalerite, galena, quartz and calcite; the pyrite, it seems, amounts to about half; the greater part of the remainder is s. and smaller quantities of galena, whereas the total quantity of quartz and calcite amounts at most to 5 per cent; Sølver states as regards the three metals: Pb 6.54, Zn 21.2 and Fe 19.1 per cent. Thus it is a very rich ore, which could become of practical importance. The structure is porphyritic, in so far as grains (up to 2 mm across) of pyrite are found in a ground-mass of a more fine-grained consistency, with a diameter of grains up to 1 mm; the form of the pyrite grains is, however, quite irregular, and this also applies to the other constituents.

Apart from the ore mentioned above, s. is also found in smaller quantities scattered in the marble; thus a mass of at least 5 cm in diameter and consisting of nearly pure, black, coarse-grained s.; further smaller particles, partly arranged in bands or layers of a lighter brown colour. S. is always associated with a little pyrite.

The Frederikshaab district.

Ivigtut (Tayler).

Tayler: Jour. Geol. Soc. London, 12, 1856, p. 140. Manual of Greenland, p. 345.

Johnstrup: 12. Skand. Naturforskaramötets Förh. Stockholm, 1880, p. 237.

Found in rather large quantities scattered among the whole mass of cryolite, together with a number of other minerals, among which quartz and siderite seem to be the only ones found in greater quantities than s. Owing to the considerable cleavage of the mineral it is in most cases difficult to trace the crystal form, and in all probability many of the grains have no regular crystal form. In a number of cases octahedrons are seen with small cubic faces, and sometimes the two tetrahedrons are seen to be different, both in size and lustre. The colour is generally black with a dark brown streak, and the percentage of iron contained in it was determined at 7 % by the manufactory Øresunds Chemiske Fabriker. In many places the cryolite also contains a number of small, pale crystals.

In the pegmatitic part of the cryolite mass, s. may be found together with quartz, microcline, siderite, galena and other minerals. It is frequently of elongated form and is flattened parallel with a cubic face. The length of the crystals may be up to 8 cm.

Taylers Havn south of Ivigtut (Ussing 1908). In a metamorphosed diabase belonging to the formation, which Ussing called the "Arsuk group" and referred to the Algonkian ? a quantity of coarse-grained, brown s. is found together with smaller amounts of galena.

The Julianehaab district.

Narssârssuk (Flink 1897).

Flink: M. o. G. 24, 1899, p. 16.

Has only been found in small quantities in a single sample together with epididymite, polylithionite, elpidite and other mine als as irregular grains of the size of a pea; sometimes there are traces of crystal faces. S. is rather disintegrated, and the surface is covered with a brown ochre; the colour light-brown.

The region of Kangerdluarssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 257.

In the "Ilímaussaq-Batholite" sphalerite occurs at several places. At Tugtup agtakôrfia it is found in rather large quantities as isolated individuals (up to 1 dm) in granular albite, together with ægirine, steenstrupine, polylithionite and other minerals. The shape irregular, the colour brown. From Nunarssuatsiaq Flink mentions the material without a more detailed description. At Naujakasik are found small grains in cavities in the pegmatite; they are bounded by the two tetrahedrons with quite small cubic faces; the colour is brown. At South Siorarssuit small (6—10 mm) irregular crystals are found in altered nepheline-syenite, being associated with albite, ilvaite, fluorite and other minerals. At Kangerdluarssuk Fjord there

are a few individuals in the pegmatite, chiefly together with microcline, arfvedsonite and ægirine; the shape irregular; in cavities small crystals (up to 3 mm) can be found, bounded by the two tetrahedrons with quite small cubic faces; all the faces are quite dull. The colour is light-yellow, but also from this locality s. is found of a darker brown colour in granular albite.

Igaliko Fjord (Rink).

Rink: Gr. II, p. 135 and App. p. 150.

Rather small granular aggregates together with galena in fluorite; the colour dark, greenish brown.

15. Chalcopyrite. $CuFeS_2$.

In Greenland this mineral is found in a number of different localities, but nearly always in very small quantities. Even though these occurrences may hardly be supposed to offer anything by way of interest or value, I have, however, considered it correct to mention briefly the localities, where the mineral has been found.

The Thule district.

Kiatak (L. Koch). A single grain (about 2 cm) of an irregular shape in sandstone. On the label it is stated to originate from the "copper vein".

The Umanak district.

Umanak.

Ball: M. o. G. 63, 1923, p. 34.

Quartz-epidote veins containing c., pyrite and secondary pyrrhotite, probably of pegmatitic origin, are said to have been found here.

The Ritenbenk district.

Igdlukúnguaq.

Löfquist and Benedicks: Jernkontorets Ann. Stockholm, 1940, p. 662.

Found in quite small quantities in the pyrrhotite containing nickel.

The Godhavn district.

Godhavn (Nygaard). In the region round the arctic station have been found specimens of oligoclase with small (1—5 mm) grains of c. Ball (M. o. G. 63, 1923, p. 34) states that on the south coast of the Godhavn peninsula pegmatite containing small masses of c. has been found.

Hvalfiske Eiland (Olrik 1863). A few crystals (up to 15 mm), sometimes associated with quartz. The shape varies from nearly ex-

clusively (111) to a combination of (111) and ($1\bar{1}1$) equally developed. Strong parting parallel to (111). The faces dull and oxidized.

Kronprinsens Ejland (Giesecke 1-10-1807). Small grains (up to 1 mm) in pyrrhotite.

The Christianshaab district.

Claushavn (Giesecke 28-9-1807). Here c. is found in hornblende schist together with cassiterite. In samples collected by Rink in this locality, c. occurs together with chalcocite in grains of one or more centimetres in diameter.

The Holsteinsborg district.

Kangerdluarssuk.

Pauly: Medd. D. Geol. Foren. 11, 1, 1946, p. 36.

Found as very thin lamellae in bornite arranged in groups with uniform direction parallel with different crystallographical directions of the bornite. Near the boundaries of the areas containing bismuth minerals there are essentially thicker lamellae of c.

The Sukkertoppen district.

Natdlusivik at Söndre Strömfjord (Søltoft 1862).

Pauly: Medd. D. Geol. Foren. 11, 1, 1946, p. 32.

It is proved that a specimen from here of c. together with galena a. o. minerals must have originated from Ivigtut.

The Godthaab district.

Qeqertánguaq (Giesecke 1808). Small grains (2—5 mm) in granular calcite together with pargasite and magnetite.

Kûlínguaq (Rink). Granular masses (up to 10 mm) in pyrrhotite.

The Frederikshaab district.

Kvanefjord. Irregularly shaped, granular masses (up to 1 cm) together with albite and epidote.

Ivigtut (Giesecke 10-8-1809).

Rink: Om Monopolhandelen paa Grønland 1852, p. 99.

Tayler Journ. Geol. Soc. London 12, 1856, p. 142. Manual of Greenland, p. 344.

Johnstrup: 12. Skand. Naturforskaremötets Förhandl. Stockholm 1880, p. 237.

Vogt: Zts. pr. Geol. 1894, p. 463.

Jarl: Fabrikken Øresund 1859—1909, Copenhagen 1909, p. 10.

Found scattered in the cryolite, together with quartz, pyrite,

siderite, sphalerite, galena and other minerals, but, with the exception of pyrite, it seems to occur in smaller quantities than the minerals mentioned above. As a rule the grains are not larger than 0.5—1 cm, but at times they attain a size of 1 dm. As a rule c. does not directly contact the cryolite, but is separated from it by sphalerite, which surrounds it on all sides; it is generally very fresh. It has only been possible to find crystals in the loose mass of gearksutite; the form is the "tetrahedron" (111) with very indistinctly developed faces. According to JARL c. is slightly auriferous.

The Julianehaab district.

Ivnatsiaq (HOFF).

HOFF: Om Alderen af de i Grønland forekommende Formationer etc. 1864, p. 41.

BALL: M. o. G. 63, 1923, p. 31.

According to HOFF c. is found in considerable quantities in various localities, among others in the continuation of the layer constituting Josvas Copper Mine. According to BALL it also plays a considerable part in this mine. In the specimens brought home c. is found in small crystals (1—2 mm) in calcite; the form as a rule indistinct, sometimes (111).

Kingigtoq at Qagssimiut (FRITZ). Small grains (1—3 mm) together with pyrite in pegmatite.

Akia (HOFF). Small grains (5—10 mm) in quartz in a 2 cm thick vein in fine-grained granite. The interstices in the quartz are filled with calcite; no other Cu-minerals were found.

East Greenland.

Wegeners Halvö.

EKLUND: Teknisk Tidsskrift, Stockholm, häfte 14, 1914.

The greatest quantity of copper known from East Greenland is found in a quartz vein about 2—3 m thick, in quartzitic schist from the Devonian; in the vein small quantities of c. with malachite are observed. A particularly high percentage of copper (about 5 % Cu) is found in the boulder from the same region mentioned on p. 13, which must be supposed to originate from a similar vein.

16. Stannite. Cu_2FeSnS_4.

The Frederikshaab district.

Ivigtut.

PAULY: Medd. D. Geol. Foren. 11, 1, p. 36.

Found as small grains (diameter up to 0.3 mm) together with chalcopyrite, sphalerite and an unknown mineral.

17. Tetrahedrite. Cu_3SbS_{3-4}.

The Frederikshaab district.

Ivigtut.

BREITHAUPT: Paragenesis der Mineralien, 1849, p. 177.

PAULY: Medd. D. Geol. Foren. 11, 1, 1946, p. 32.

BREITHAUPT mentions t. from Joikaet (Ivigtut) together with galena, sphalerite and chalcopyrite; PAULY has found microscopical grains in galena.

18. Luzonite. $Cu_3(SbAs)S_4$.

The Holsteinsborg district.

Kangerdluarssuk.

PAULY: l. c. p. 36.

This mineral which has the same composition as enargite (Cu_3AsS_4) is found as microscopical lamellae in bornite.

19. Pyrrhotite (Troilite). $Fe_{11}S_{12}$ (FeS).

The Thule district.

Kap Parry (MYLIUS-ERICHSEN 1903). At a neighbouring mountain called Fedtstensfjældet (ɔ: the potstone rock) a number of specimens of fine-grained pyrite with smaller quantities of pyrrhotite are found.

The region round Kap York.

BØGGILD: M. o. G. 74, 1927, p. 21.

To be found in rather large quantities in the meteoric iron from Savik, and is presumably also found in the other blocks from Kap York (cf. p. 18). The number of grains is about nineteen in every dm^2 polished surface, and the area 0.64 % of the slice investigated. The greater part of the troilites are rather regularly rounded, a smaller part (about 30 %) rod-shaped. A few small crystals have been found, which are almost of the shape of a hexagonal prism with a basal plane, but the faces are so indistinctly developed that they cannot be determined with certainty. In the troilites small quantities of chromite may occur.

The Umanak district.

Ivnarssuaq (NOE-NYGAARD 1939). The occurrence consists of a black, fine-grained quartz rock with a large number of grains of a red

mica. All the quartz grains are intermixed with an immense quantity of quite small black grains. In this rock there is a pegmatitic quartz-mass, in which the pyrrhotite forms irregular veins.

Storøen (Giesecke 24-4-1811).

Rink: Ngr. p. 46.

Giesecke mentions that near Akia there are great quantities of a magnetic iron ore together with hornblende schist; this is possibly the pyrrhotite recorded by Rink from the north-eastern side of the island, where it lies in the shape of large tumbled-down blocks about 0.7 m in diameter. A single block in the Mineralogical Museum of Copenhagen consists of almost quite pure p.

Ũmánatsiaq (Rink).

From here only a single sample 1 dm in diameter, and unaccompanied by other minerals.

The Ritenbenk district.

Kûgánguaq (L. Koch 1918). A single sample which seems quite pure and with shining parting faces; the individuals interpenetrate, with very irregular boundaries.

Igdlukúnguaq (Nordenskiöld 1870, Steenstrup 1871).

Nordenskiöld: Öfvers. Vet.-Akad. Förh. Stockholm, 1870, p. 1070.

Steenstrup: Vid. Medd. Nat. Foren. 1875, p. 304.

Lawr. Smith: Ann. Chim. Phys. 16, 1879.

Steenstrup: M. o. G. 24, 1900, p. 278.

Nordenskiöld found the mineral in great blocks, lying in the sand near a basalt vein: Steenstrup found it *in situ* in the vein as a very large mass, the visible dimensions of which were 3 by 1.5 m; estimated weight 28.000 kg. The outcrop is rather analogous with the native iron in the basalt; the rock differs from its usual appearance in the vicinity of the pyrrhotite, and both minerals illustrate in a peculiar manner that masses with a particularly large specific gravity have been brought up by the magma.

The pyrrhotite was in 1871 quite fresh with shining parting faces (cf. pentlandite p. 42); later it has become greatly disintegrated, dark with a green coating of zaratite. Enclosed in the pyrrhotite is a chlorophæite-like mineral, and in numerous cavities there are small crystals of magnetite and siderite, more rarely of pyrrhotite (1—3 mm) bounded by (0001), $(10\bar{1}0)$, $(20\bar{2}1)$ and $(11\bar{2}0)$. The faces are on the whole rather well developed. Analysis by Lawr. Smith: S 36.85, Fe 53.01, Cu 2.43, Ni 3.11, Co 0.78, P 0.42, insol. 3.20 = 99.80.

Marraq (Steenstrup 1883). Here a block was found about 0.5 m in diameter. As the locality is quite close to the boundary of the basalt area and the Pre-Cambrian, it is not apparent where it belongs. When

microscopically investigated it proves to consist of a rather pure p. which, however, contains a number of quartz grains scattered throughout the mass.

The Godhavn district.

Qitdlûssat Nûa near Skansen (the redoubt) (Porsild 1908).

A large block was found, consisting of a quartzite which was quite black owing to disseminated pyrrhotite; also larger (1—2 cm) grains of p., in such quantities that they seem to constitute more than half of the block, were present.

Uivfaq.

Nordenskiöld: Öfvers. Vet.-Akad. Handl. Stockholm, 1870, p. 973.
Nauckhoff: Bihang Vet.-Akad. Handl. Stockholm, 1, 1872, No. 6.
Steenstrup: Vid. Medd. Nat. Foren. 1875, p. 284.
Lawr. Smith: Ann. Chim. Phys. 16, 1879.
Törnebohm: Bihang. Vet.-Akad. Handl. Stockholm, 5, 1878, No. 16.
Löfquist and Benedicks: l. c.

As Nordenskiöld started from the hypothesis that the telluric iron was meteoric, it was natural that he came to mistake the ferrous sulphide for troilite. Nauckhoff subjected it to an analysis: Fe 52.94, Ni 5.06, Cu traces, S 33.41, silicate 8.59. When Steenstrup had proved that the iron was telluric, he also proved how unjustifiable it was to conclude from this analysis that the mineral was troilite, even though the analysis otherwise agrees very well with the composition of the troilite. Lawr. Smith and Törnebohm followed Steenstrup, whereas, on the other hand, Löfquist and Benedicks have gone back to the name of troilite, although the reason for doing so does not appear from the treatise. The mineral is found as thin plates or rounded grains of the size of a pea, and this also applies to the other occurrences of iron.

Sioraq and Eqaluit in Disko Fjord (Porsild 1915). In both localities fragments of rather pure pyrrhotite have been collected.

Kronprinsens Ejland (Nyeboe). A sample consisting of pyrrhotite and quartz with quite small quantities of chalcopyrite.

The Egedesminde district.

Akugdlît (Giesecke).

Irregularly shaped masses together with augite, biotite and other minerals. In the p. regularly developed octahedral crystals of pyrite are enclosed.

Augpalârtoq (Giesecke 19-8-1810).

From here is described a nearly 1 m thick vein consisting of chalcopyrite, pyrite, pyrrhotite and "Leberkies" (p. or marcasite).

The Godthaab district.

Bjørneø (Giesecke). Fine-grained mass together with quartz etc.

Kolinguaq (Rink). Granular, irregularly shaped masses (1—3 cm) together with chalcopyrite in numerous cavities. Strong parting parallel to the base. The surface greatly disintegrated.

The Frederikshaab district.

Ivigtut (Steenstrup 1888 and 1892). Two analogous specimens of p. together with chalcopyrite, sphalerite, pyrite, siderite and cryolite. Distinct crystal faces on p. cannot be observed. Rather pure, fresh with a very faint parting and an almost conchoidal fracture. Grain size about 2 cm. Other cases of macroscopic p. have, in spite of all investigations, not been found in Ivigtut. Bøgvad (Medd. D. Geol. Foren. 10, 1942, p. 119) has, however, found that smaller grains (less than 1 mm) are of common occurrence in several of the ores occurring in the cryolite, particularly in the chalcopyrite.

East Greenland.

Vestfjord in Scoresby Sound.

Eklund: Teknisk Tidsskrift, Stockholm, häfte 14, 1944.

It is stated that Backlund has in this place found veins of pyrite, up to 5 m thick, and that some of these contain p. A single vein of 10 m is said to contain 50 % of this mineral.

20. Millerite. *NiS.*

The Thule district.

Port Foulke.

Emerson: Amer. Geologist, 35, 1905, p. 94.

From this locality a number of rocks and minerals are described, among others a quartz-biotite rock, with spinel and dumortierite as some of the constituents. M. chiefly occurs as very small particles, but sometimes they are as much as 6 mm in diameter. The cleavage angle is measured at 144°15′ (theor. 144°8′).

The Godhavn district.

Uivfaq.

Löfquist and Benedicks: Jernkontorets Ann. Stockholm 1940, p. 660.

M. is recorded as thin lamellæ parallel to the base and the prism in troilite.

21. Galena. *PbS.*

Galena has only been found in few localities in Greenland, and with the exception of Marmorilik and Ivigtut the occurrences are quite insignificant. In the following all known occurrences are mentioned.

The Umanak district.

Marmorilik (Dreyer-Jørgensen and Noe-Nygaard 1939). As to the occurrence (see p. 43); it appears that the amount of g. must be rather large, since lead constitutes about 6.54 % of an apparently very large mass.

The Ritenbenk district.

Igdlukúnguaq.

Pauly: Medd. D. Geol. Foren. 11. 1, 1946, p. 31.

Named as a doubtful constituent of the pyrrhotite, as seen in the ore microscope.

The Sukkertoppen district.

Natdlusivik at Söndre Strömfjord. (Søltoft 1862).

Pauly: Medd. D. Geol. Foren. 11, 1, 1946, p. 32.

It is proved that a specimen from here of g. together with chalcopyrite must have come from Ivigtut.

The Godthaab district.

Fiskenæsset. A granular mass together with quartz; size of individuals up to 2 cm.

The Frederikshaab district.

Ivigtut.

Schumacher: Verzeichniss der in den Dänisch-Nordischen Staaten sich findenden Mineralien, 1801, p. 143.

Giesecke: 10-8-1809.

Rink: Om Monopolhandelen paa Grønland, 1852, p. 99.

(Tayler): Peterm. Mitt. 1856, p. 118. — Ill. Lond. News, 1856, No. 783. — Litt. Gazette No. 2039.

Tayler: Quart. Journ. Geol. Soc. London, 12, 1856, No. 783. — Manual of Greenl., p. 344.

Rink: Gr. II, p. 135, App. p. 148—49.

Sadebeck: Zeits. D. Geol. Gesell. 26, 1874, p. 639.

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 237.

Jarl: Fabrikken Øresund 1859—1909. 1909, p. 10.

Legraye: Ann. Soc. Géol. de Belg. 61, 1937—38, B. p. 109.

Is found distributed in the cryolite together with quartz and a number of different ores; also found in the pegmatite accompanying the mass of cryolite. As a rule the crystals are rather small (1—2 cm),

but there are also certain areas, where both g. and the other minerals occur as much larger individuals and also in far greater quantities in proportion to the cryolite. The g. is frequently idiomorphic towards the cryolite, but it is not easy to remove the crystals without breaking them. The form is always (100) and (111); the faces are indistinctly developed, uneven and impure. According to SADEBECK it is found twinned with tw. pl. (441).

According to TAYLER the g. from Ivigtut contains 0.18 % of silver; according to JARL the quantity of silver in the upper parts is 0.7 %, in the lower only half that percentage. As in the south-eastern part of the cryolite mass there was a fairly large quantity of g. aggregated in one locality, an I an establishment was founded under the leadership of TAYLER with a view to working it. A pit was opened up, passing in a horizontal or a faintly oblique direction under the rock. After a couple of months the work had to be abandoned, as the galena was exhausted.

In conclusion it must be observed that LEGRAYE has recently given a summary of the sequence of the crystallization of the three ores, viz. g., chalcopyrite and sphalerite and other phenomena connected with these minerals.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 229, and 24, 1901, p. 15.

Found in small quantities, partly as crystals, partly as irregularly shaped masses. The crystals are indistinct cubes.

Siorarssuit, South (USSING 1900).

BØGGILD: M. o. G. 25, 1902, p. 50.

Found in the metamorphosed sodalite-syenite together with ilvaite, albite, fluorite and calcite. G. is nearly always of a later formation than these minerals and fills out occasional cavities between them, sometimes in such a manner that a single individual branches into a number of continuous cavities. Of rarer occurrence are crystals, exclusively cubes.

Nunasarnaussaq (GIESECKE 20-7-1809). GIESECKE records the finding of "schönen Bleiglanz" in diabase, together with crocidolite.

Igaliko Fjord (RINK).

RINK: Gr. II, p. 136.

Quite small grains together with sphalerite in fluorite.

East Greenland.

Wegeners Halvø.

EKLUND: Teknisk Tidsskrift, Stockholm, häfte 14, 1914.

The ore is found in small, very elongated pockets, the dimensions of which are generally between 2 and 10 cm^3; they consist of a brecciated calcite with cubes of galena. On Wegeners Halvø Noe-Nygaard in 1931—32 collected crystals of g. without any connection with other minerals; the size is up to 2 cm in diameter, the form cubic with octahedrons; whether it is exactly the same occurrence as the one mentioned above is not known.

22. Covellite. *CuS.*

The Holsteinsborg district.

Kangerdluarssuk (Lassen 1876).

Pauly: Medd. D. Geol. Foren. 11, 1, 1946, p. 36 and 45.

Small particles (diameter up to 1 cm) in bornite. The formation seems to have originated from fissures, and the c. has very often a dendritical aspect.

The Frederikshaab district.

Ivigtut.

Pauly: l. c. p. 32.

Found as microscopical grains in limonite together with chalcopyrite a. o. minerals; is assumed to be of secondary origin.

23. Valleriite. $Cu_3Fe_4S_7$.

The Ritenbenk district.

Igdlukúnguaq.

Pauly: l. c. p. 31.

This mineral, which is a sulphide of Fe and Cu with a small amount of Ni, is found as microscopical grains in chalcopyrite, enclosed in the pyrrhotite. The form of the individuals is irregular.

The Frederikshaab district.

Ivigtut.

Pauly: l. c. p. 32.

Also from here the existence of v. is named without any further description of its mode of occurrence.

24. Bismuthinite. Bi_2S_3.

The Holsteinsborg district.

Kangerdluarssuk.

Pauly: l. c. p. 36.

Found as elongated grains up to a few mm long, together with bismuth

enclosed in bornite. At the boundary between the bornite and the two bismuth minerals there is a constant, thin layer consisting of two minerals, which it has not been possible to determine.

25. Cosalite. $Pb_2Bi_2S_5$.

The Holsteinsborg district.

Kangerdluarssuk.

Pauly: l. c. p. 36.

Found as microscopical grains in bismuthinite; all the properties correspond very well with those of c., which is a sulphide of Bi with Pb (or Ag), but the author does not consider the determination as perfectly certain.

26. Pyrite. FeS_2.

This mineral is very widely distributed in Greenland, though everywhere, possibly with the exception of Marmorilik, only occurring in rather small quantities; in the following only a selection of the most important localities will be given.

The Thule district.

Kap Parry, see above under pyrrhotite.

Granville Fjord (L. Koch). Here various samples have been collected, chiefly consisting of sandstone with a few small (up to 2 mm) pyrite impregnations, mixed with quartz. A few samples of pure fine-grained p. are at hand.

Red Head, see above under sphalerite.

The Upernavik district.

Langø (Ussing 1886). Crystallized together with graphite, calcite and quartz; the crystals well developed, exclusively cubic with faintly striated faces; the size 2 cm.

Ingnerit (Fenker 1939). A group of crystals, 1—2 cm in diameter; skeletal cubes with indistinct rounded faces, on the outside coated with a layer of limonite. These seemingly very insignificant crystals are peculiar because they occur in a black microcrystalline rock, the structure of which seems to be quite unique. The ground-mass consists of quartz, the structure of which must rather be called spherulitic and in any case has a greatly undulating extinction. In this mass the pyrite is enclosed, sometimes as small cubes, but most frequently in the shape of small globules, surrounded by one or two hollow spheres, so that the section shows a central disc, surrounded by one or two rings which do not touch (fig. 7).

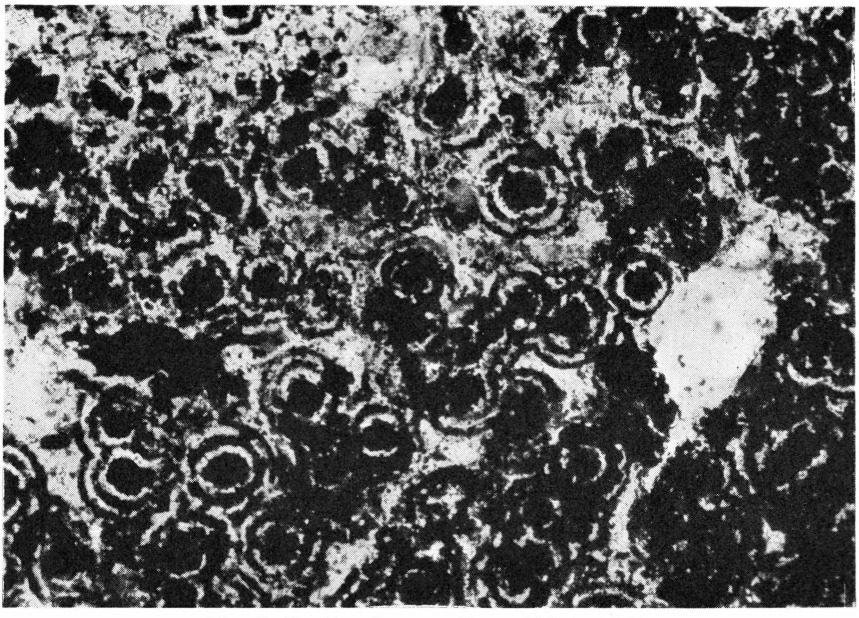


Fig. 7. Pyrite; Ingnerit. c. 106:1, 1 Nic.

The Umanak district.

Marmorilik (Dreyer-Jørgensen and Noe-Nygaard 1939). Here the pyrite is found in the fine-grained ore described above (p. 43). Also outside this locality pyrite may be found, sometimes in the shape of very large (up to 1 dm) crystals, the shape of which is rather cubical, but with extremely indistinct, greatly rounded faces. In 1940 Ferdinand Broberg has collected many small (2—10 mm) crystals above the settlement; in most instances the only form is (210), and more rarely very small faces of (100) and (111) are found. Most of the crystals are very imperfectly developed, but some few crystals are bounded by well developed faces, these are rather even and shiny, and all have a coating of a black colour.

Paornat on Storøen.

Schumacher: Nat. Selsk. Skr. 4, 2. Hæfte, 1798, p. 231.

Rink: Gr. I, 2, p. 215.

Fragments of cubic crystals (according to Schumacher there are also cubo-octahedrons etc.) all very porous and disintegrated. As to the occurrence nothing is known. This is the first mention of the mineral from Greenland.

Qaersut (Rink). Concretions (about 5 cm) in graphite, formed by alteration of lignite. The shape irregularly nodular, the surface uneven.

The Ritenbenk district.

Isúnguaq (Steenstrup 1872). Regular spherical concretions have been found of up to 8 cm in diameter. A few of them with small crystals (cubo-octahedrons) on the surface.

The Godhavn district.

Fortunebay (Otto Rosing). Crystals in gneiss: the size about 1 cm. cubes with striated faces.

Godhavn (Porsild 1946). On the beach west of G. was found a concretion of pyrite of a regular spherical form, diameter 3.5 cm. The pyrite contains a very large number of quartz grains, the specific gravity being 3.2, which gives a volume percentage of 24 pyrite and 76 quartz.

The Egedesminde district.

Isuamiut (Porsild). Here a slate formation has been found, in which also quartzite occurs, more or less penetrated by pyrite, the latter generally so finely distributed that the slate becomes black in colour, but it may also almost entirely displace the quartzite.

Manîtsoq (Steenstrup 1872). Irregularly formed lump (7 cm), the surface brown and oxidized; it is not associated with other minerals, excepting a few quite small quantities of calcite in cavities, where also very small cubic crystals are seen.

Akugdlît (Giesecke 17-8-1812). Recorded as occurring in association with mica schist. At the Mineralogical Museum of Copenhagen crystals (up to 1 cm) exists in pyrrhotite and augite. Combination (111) with (100): The faces well developed.

Sungaussaq (Giesecke 10-6-1808, and 17-8-1812).

Rink: Ngr. p. 41.

According to Giesecke, the pyrite is chiefly found in association with chalcopyrite in layers in mica schist; the samples, which have been collected by various people, offer no special points of interest, with the exception of a particularly large crystal collected by Rink; its maximum diameter is 13 cm, and it weighs 1.5 kg: the form is (100) with smaller faces of (210); the crystal is very incompletely developed, being intersected by fissures and greatly disintegrated at the surface.

Ũmánârssuk (Giesecke). From this locality a number of loose crystals have been collected in disintegrated clay slate: size 5—15 mm. Cube with small octahedral faces rather badly developed and coated with a layer of rust.

Nordre Strømfjord. Loose crystals (about 5 mm), regular cubes

with rounded edges and rounded faces with a curious coating, consisting of an amorphous, not definable substance.

The Godthaab district.

Ameralik (RINK).

RINK: Gr. II, App. p. 150.

Loose crystals (up to 3 cm); as to the manner of occurrence nothing is known. Common form (100), sometimes rather large faces of (210). The two faces are highly striated and curved planes.

Qeqertánguaq in Ameralik (GIESECKE 20-9-1808). It is possibly the same locality as the preceding one, seeing that GIESECKE mentions the well-known loose pyrite crystals found in grey clay on the beach.

The Frederikshaab district.

Kangârssuk (WEBER 1862). Vein-like mass (thickness 4 cm) consisting of fine-grained pyrite, arsenopyrite and quartz.

Ivigtut (GIESECKE 10-8-1809).

GIESECKE: Edinb. Phil. Journ. 6, 1821—22, p. 141; Manual of Greenl. p. 341.

JOHNSTRUP: 12. Skand. Naturforskaremötets Förh. Stockholm 1880, p. 237.

Found distributed in the whole of the cryolite mass, both in its main part and in the pegmatite to the west of the latter. It is most frequently found in association with siderite, quartz, sphalerite, chalcopyrite, galena and arsenopyrite, the two latter, as it seems, in smaller quantities than the three former; it is most frequently of a distinct crystalline form (JOHNSTRUP holds the opposite view, but the author has nearly always seen it with crystal faces). The most common combination is (100) and (210); the crystals are very irregular with coarse striae produced by oscillatory combination. Of rarer occurrence is a combination with (111) predominating and then (210), (100) and (421). The faces are in part extremely shiny; peculiar is a combination striation between (111) and (421).

A fissure has been found in black cryolite, the walls of which were densely covered with shining crystals (100) and (111) of the size of a millimeter.

The Julianehaab district.

Panernak (STEENSTRUP 1888). Numerous small crystals of p. (length of edge about 2 cm) are found in a red granite. Cubes with well-developed faces.

Igaliko? The samples were handed in by the Greenlander ENOK DAVIDSEN from Igaliko, and presumably originated from a neigh-

bouring locality. In a lighter or darker grey, extremely fine-grained mass very large quantities of pyrite crystals are embedded, most of them very small, a few of them, however, about 1 cm. Combination (210) with smaller faces of (100), the faces rather well developed. The ground-mass is very characteristic. In some cases it consists of fine-grained quartz, set with small phosphorite concretions, frequently very close to one another. Sometimes there are veins of fluorite, and in some cases the granular mass also consists of the same material, in which numerous quartz crystals are embedded, but both of these minerals still contain the small phosphorite nodules.

East Greenland.

Auspicia on the south coast of Clavering Ø.

Eklund: Teknisk Tidsskrift, Stockholm, häfte 14, 1914.

This very considerable occurrence consists of a vein with an average thickness of about 1.3 m and containing about 88 % pyrite, which encloses very greatly altered fragments of the surrounding rocks. The pyrite contains 0.5 gr gold and 25 gr silver per ton.

Hochstetters Forland (Rosenkrantz 1945). In fissures in the Eleonorebay formation, northwest of Jarner's coal mine, masses of pyrite (up to 10 cm in diameter) were found interspersed with calcite crystals; they are highly porous, and the holes are for the greater part filled with calcite. Numerous very small crystals, as it seems exclusively cubic, are scattered about.

Jørgen Brønlunds Fjord (Troelsen 1947). Troelsen, M. o. G. 149 No. 2, 1949, p. 26.

In a small crater, under deposits of sulphates (gypsum, ferrofibrite and copiapite) there was found a mass consisting of a powder of sulphur in which there is a large lot of small particles (up to 1 cm) of pyrite; the form of these is very irregular, most like groups of crystals or crystal skeletons, but they are so imperfectly developed, that their form is not to be determined with certainty. Upon the pyrite we often find small gypsum crystals.

27. Bravoite. $(Ni,Co,Fe)S_2$.

The Ritenbenk district.

Igdlukúnguaq.

Löfquist and Benedicks: Jernkontorets Ann. Stockh. 1940, p. 662.

Reported to occur as a microscopical constituent in the pyrrhotite, where it forms fine-grained masses in association with pentlandite (so-called nifesite). The bravoite is by some scientists regarded as a nickeliferous variety of pyrite, by others as a special mineral.

The Godhavn district.

Uivfaq.

Löfquist and Benedicks: ibid.

Found under exactly the same conditions as in the preceding locality.

28. Marcasite. FeS_2.

The Frederikshaab district.

Ivigtut (Giesecke 10-8-1809).

Pauly: Medd. D. Geol. Foren., 11-1-1946 (p. 32).

Mentioned by Giesecke as having been found in the tin veins of the pegmatite surrounding the cryolite. Pauly mentions m. as microscopical grains in limonite in fissures in chalcopyrite and suggests that it is of secondary origin.

29. Löllingite. $FeAs_2$.

The Julianehaab district.

Naujakasik (Flink 1897).

Flink: M. o. G. 14, 1898, p. 245.

Traces of löllingite are said to be found in one small sample of nepheline-syenite.

30. Arsenopyrite. *FeAsS.*

The Umanak district.

Ũmánatsiaq (Giesecke 18-4-1811). Reported to have been found in association with pyrite, disseminated in gneiss, which is stained ocherous by these minerals. The a. is oxidized and black on the surface.

The Frederikshaab district.

Kangârssuk (Weber 1862). Together with pyrite and quartz in a fine-grained mass, shaped like a vein and 4 cm thick. It occupies the central part of the vein in association with quartz.

Ivigtut (Giesecke 10-8-1808).

Tayler: Journ. Geol. Soc. London 12, 1856, p. 140. Manual of Greenland, p. 345.

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm 1880.

Found in the pegmatite bounding the main mass of the cryolite and in the smaller tin veins in the granite. It occurs in association with quartz, felspar, ivigtite, fluorite molybdenite and columbite, in addition to the cryolite itself and the different minerals found in the principal mass of the cryolite. The age of this mineral in relation to the other minerals varies, but most frequently crystal faces are found

fully developed. The form varies; sometimes it is only (110) and (001), the latter face highly striated, sometimes also (014) or only (110) and (014), this face being always greatly striated. Upon the whole the crystals are irregular and frequently skeletal. The size of the individuals up to 5 cm. TAYLER mentions a. as gold-bearing.

The Julianehaab district.

Kangerdluarssuk (USSING 1908).

In a boulder containing some of the minerals characteristic of the nepheline-syenite (microcline, ægirine etc.) a single crystal was found, 6 mm in length. The form could not be determined with certainty.

Nanortalik (GIESECKE 7-8-1806).

STEENSTRUP: Till. B til Rigsdagstidende 1877—78, p. 12.

EBERLIN: M. o. G. 9, 1888, p. 254.

JESSEN: M. o. G. 16, 1896, p. 139.

Found in a leptitic rock consisting of quartz, white felspar and a little mica: a. occurs in association with tourmaline and garnet, according to STEENSTRUP right at the water line, partly covered by the tide in a locality named "Nybørs". The form is elongated masses (up to 8 cm) without any distinct crystalline form.

East Greenland.

Sangmissoq at Ikeq (KNUTZEN 1884). Irregularly formed masses (up to 3 cm) in association with quartz, felspar and biotite.

Slightly south of Kap Walløe (EBERLIN 1884).

EBERLIN; M. o. G. 9, 1889, p. 254.

Found in gneiss; no details recorded as to the occurrence.

31. Molybdenite. MoS_2.

The mineral has been found in several localities in the Pre-Cambrian rocks, but never in particularly great quantities. It is mentioned with certainty for the first time by GIESECKE in 1808. The occurrences known up to the present are the following:

The Egedesminde district.

Ujaragtarfik (NYEBOE 1912).

BALL: M. o. G. 63, p. 39.

From here hornblende gneiss is mentioned, which is traversed by quartz-felspar pegmatite veins and quartz veins; the latter contain molybdenite and a little pyrite. M. is particularly abundant in the boundary areas of the veins; it is tabular in shape, the orientation being parallel to the direction of the veins.

Manîtsoq (GIESECKE 26-8-1812).

RINK: Ngr. p. 41.

Found as small foliated masses (2—5 mm) in mica schist together with quartz, actinolite, diopside, calcite, oligoclase, garnet and tourmaline.

Agto (PJETURSSON 1897).

PJETURSSON: M. o. G. 14, 1898, p. 289.

Found as small grains (1—2 cm) in microcline.

The Sukkertoppen district.

Atangmik. From here NYEBOE sent home a fragment of granite with a number of small (0.5 mm) molybdenite particles.

The Godthaab district.

Alángorssuaq (GIESECKE 23-6-1810). Recorded as having been found in mica schist in association with tremolite, epidote and other minerals. In a small sample at the Mineralogical Museum of Copenhagen there are small (up to 1 cm) irregularly formed grains.

Narssaq (GIESECKE 26-5-1810).

HÖRNES: Uebers. Darst. d. Mohsischen Mineralsystemes, 1857, p. 115.

KENNGOTT: Miner. Forschungen im J. 1855, 1856, p. 104.

MOSES: Amer. Journ. Sci. 17, 1904, p. 364.

Tabular masses (up to 3 cm), irregularly bounded in a quartz vein in granite, which also contains diopside, pyrite and garnet. Curiously enough the crystals from this occurrence were the first on which an attempt was made to determine the axial ratio of the mineral; as to details of this see the literature quoted.

Qarajat (GIESECKE 13-9-1808). Recorded as found in granite associated with pyrite and magnetite.

Fiskenæsset.

From here there are two samples, one of which was collected by STEENSTRUP in 1889, the other one by some person unknown in an older period. The samples weigh 62 and 600 gm respectively, and as they are both, as far as can be seen, completely pure without any intermixture of other minerals, they point towards the occurrence having been rather rich. Whether the occurrence is situated at Fiskenæsset itself or at some locality in the neighbourhood it is not possible to say for certain.

The Frederikshaab district.

Iluilârssuk (STEENSTRUP 1888).

A few grains (diameter 15 mm) in pegmatite, consisting of quartz and oligoclase.

Kangârssuk (Rink 1852).

Rink: Gr. II App. p. 150.

Tabular crystals (up to 5 cm) with quartz, garnet and augite. The form sometimes distinctly hexagonal, most frequently quite irregular.

Ivigtut (Tayler).

Tayler: Journ. Geol. Soc. London 12, 1856, p. 140. Manual of Greenland 1875, p. 345.

Johnstrup: 14. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 242.

Occurs crystallized on quartz in the quartz-felspar mass in the western part of the cryolite mass, in association with cryolite, ivigtite, fluorite, cassiterite, arsenopyrite and columbite, together with other minerals found in the main mass of the cryolite. Forms either radiating or rather irregular masses of about 1 cm, or it is found in cavities as crystals, which sometimes may be fairly well developed, hexagonal and bounded by a prism and a flat pyramid which, however, cannot be more definitely determined.

The Julianehaab district.

Kangerdluarssuk (Flink 1897).

Small particles (a few mm) in pegmatite with felspar, rinkite, arfvedsonite etc.

Ujaragtarfik (Eberlin 1885).

Ball: M. o. G. 63, 1923, p. 39.

Small crystals (about 5 mm) in granite pegmatite; rather regular, hexagonal tables.

Agpaliarssuit, one of the southern Kitsigsut islands. Numerous small particles in granite.

East Greenland.

Inugsuit (Eberlin 1884).

Small crystals (about 5 mm) in granite-pegmatite; rather regular hexagonal tables.

Angmagssalik (Johan Petersen).

Cleavage fragments of up to 1.5 cm in diameter.

(Smaltite). $CoAs_{2-3}$.

According to Giesecke (25-6-1809) this mineral is said to be found at Pardlit in the Julianehaab district, as inclusions in reddish felspar. The determination can hardly be regarded as perfectly reliable.

III. CHLORIDES AND FLUORIDES

32. Halite. *NaCl.*

The Upernavik district.

Upernaviarssuk (Giesecke 19-7-1809). From here there is a record of beautifully crystallized cubes of h., found in hollows in the shore-cliffs.

East Greenland.

Geologfjord (Poulsen 1929). Poulsen: M. o. G. 74, 1930, p. 307.

At a locality called Spiralkløften (ɔ: the spiral-creek) rock-salt pseudomorphs were found on the bedding planes in sandstone, together with various indefinable figures. The sides of the crystals are as much as about 3 cm in length. The faces are, as may be imagined, extremely rough, but in most of the crystals, which have a cubic face parallel to the bedding plane, the cubic figure is quite unmistakable; if the crystal is placed in an oblique position, especially with a trigonal axis at right angles to the bedding plane, a later pressure has changed it into an obtuse rombohedron. All the crystals have the form which is ordinary for the mineral, the centres of the planes being depressed in relation to the outer parts. Rock-salt crystals of such a considerable size must presumably be regarded as a proof of a desert climate, and it is in so far characteristic that layers of gypsum have been found at the same level on Ella Ø.

Strindbergs Land. (Teichert 1931). Teichert; M. o. g. 95, 1933, p. 51.

At a place called Broget Dal a quite similar formation was found; the pseudomorphs are smaller (up to 1 cm) but very regular (fig. 8).

33. Fluorite. CaF_2.

The Thule district.

Holms Ø. The Mineralogical Museum of Copenhagen possesses a small green-coloured cleavage fragment (diameter 1—3 cm) which has been found in this place.

The Upernavik district.

Upernaviarsuk (GIESECKE 19-7-1807). Here green f. is mentioned together with bluish quartz, green felspar, scapolite and magnetite in granite.

Naujat (GIESECKE 24-7-1807). From here there is a record of sapphire-blue f., interspersed as fine grains with graphite in granite.



Fig. 8. Pseudomorphs after halite. Strindberg Land. 1:1.

The Umanak district.

Marmorilik (NOE-NYGAARD 1939). A single crystal individual embedded in marble; the size rather considerable, the greatest dimension being 5 cm. The form very irregular, partly skeletal. The colour bluish-black.

The Godhavn district.

Kronprinsens Ejland (PJETURSSON 1897).

PJETURSSON: M. o. G. 14, 1898, p. 289.

Is recorded to have been found in pegmatite veins.

The Egedesminde district.

Ivnârssulik. Also from this locality PJETURSSON mentions f. as found in pegmatite veins. Furthermore, he received a fragment at Egedesminde, no special locality having been given. A clear, colourless cleavage fragment (3 cm).

The Frederikshaab district.

Ivigtut (GIESECKE 18-8-1809).

JOHNSTRUP: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 240.

JUL. THOMSEN: Overs. k. d. Vid.-sels. Forh. 1898.

JUL. THOMSEN: Overs. k. d. Vid.-sels. Forh. 1904, p. 53.

STRUTT: Proc. Roy. Soc. (A), 80, 1908, p. 56.

JARL: Fabrikken Øresund 1859—1909, København 1909.

LANGE: Studien über die Zusammensetzung heliumführenden Mineralien Inaug.-Diss. Halle. 1910.

STEENSTRUP: M. o. G. 34, 1910, p. 144.

BØGGILD: M. o. G. 50, 1912, p. 177 and Zts. Kryst. 51, 1913, p. 614.

STOICOVICI and GLISZCZYNSKI: Zentrbl. Min. etc. 1938, A, p. 113.

BÖGVAD. Medd. D. Geol. Foren, 10, 1945, p. 651,

Here f. occurs in a number of different forms; whether they are to be called definite types it is difficult to say; new collections may perhaps bring forth new forms and transition forms between the former ones. This especially applies to the first five numbers, which do not present particularly characteristic phenomena. The three latter, on the other hand, are something quite apart and in various respects very peculiar.

1. In the common white cryolite only a single little fragment (about 1 cm) has been found; the colour greenish.

2. The only form with freely developed crystals occurs at the south-western end of the cryolite mass; the crystals are found on quartz crystals, together with siderite, felspar etc., and they project freely into cavities. Form: (111) with smaller faces of (100) and (110). The faces are most frequently coated with a thin brown layer, but otherwise they are well developed. The colour black, in thin splinters violet.

3. A fine-grained mixture of f. with mica (ivigtite?) in which quartz, felspar, galena, siderite and other minerals are found; the colour violet.

4. A large-grained mixture of f. with dark cryolite, siderite, chalcopyrite and others. F. is faintly greenish or reddish.

5. Beautiful light-green f. which together with quartz and felspar form a kind of pegmatite veins in granite; none of the minerals, which are otherwise characteristic of the locality, occur.

6. Brownish red, almost opaque crystals in black cryolite together with siderite, chalcopyrite, galena and other minerals. F. is very impure and, according to STEENSTRUP, contains small hematite particles in fissures, which produces the red colour, while the parts without hematite are grey or brownish. The different colours are often very regularly distributed into zones. The form of the crystals is rather like type 2, but the faces are very irregular and dull. When faintly

heated helium is developed, the evolution being accompanied by an unusually strong light; after being cooled the crystal is colourless and the light phenomenon can not be repeated. THOMSEN (1898) found that the mineral contains a couple of percentages of fluorides of the cerium metals and is of the opinion that the helium is due to the presence of the latter. Later on, in 1904, he analysed the gasses developed by ignition, with the result that 1000 gm of the mineral contains CO_2 715 cm³, CO 20, H 66, N 5, He about 24. If the fluorite is treated beforehand with strong acids a comparatively large part of the other gasses disappear, so that the amount of helium makes more than 60 per cent of the CO_2-free gas. JARL found that f. is rather strongly radioactive, and that the black cryolite surrounding it is faintly radioactive. This property seems to be a result of a content of yttrocerite embedded in f., whereas f. itself and the surrounding cryolite only contains emanation. JARL was also of the opinion that the black cryolite owed its dark colour to the radioactivity, and that this colour disappeared together with the latter, when the mineral was heated; this, however, seems to be rather doubtful, as it has not been possible to produce the dark colour in cryolite by means of a radium preparation[1]), and also parts of dark cryolite have been found, without any contents of fluorite. STRUTT has tested the radioactivity in the f. in question, and has found it quite inconsiderable when compared with the ample quantities of thorium emanation, which he thinks has some bearing upon the helium contents. LANGE divides f. into two parts by means of a liquid, the specific gravity of which is 3.19, and he finds that the heavier of these, which must necessarily contain the radio-active constituents, when analyzed yielded 2.05 % UO_2 and 1.68 PbO. Upon the whole, one gets the impression that conditions are as yet far from being elucidated.

7. Very peculiar is also a crust-shaped or stalactitic f., contained in thin fissures in the common white cryolite, nearly always intimately intergrown with thomsenolite, the outward appearance of which bears a nearly complete resemblance to the fluorite. In association with the stalactitic minerals are nearly always found layers of crystalline thomsenolite, and in fissures there are often extremely clear, small crystals of this mineral. The colour of the stalactitic minerals is violet or reddish-brown with numerous transitions; sometimes they are translucent, sometimes with a very strong pearly lustre. When exposed to a faint ignition, they burst into thin nacreous plates. F. has been analyzed by CHR. CHRISTENSEN with the following result: Ca 47.72, Al 0.79, Mg 0.18, Na 1.42, F 47.81, H_2O 1.49 = 99.41.

[1]) On the other hand KREUZ (Anz. Akad. Wiss. Krakau, March 1896, p. 114) reports that cryolite when for rather a long time exposed to cathode rays gets perfectly black, which colour, however, disappears after a few minutes.

8. The most peculiar manner of occurrence of f. seems, however, to be its connection with chiolite. In this mineral which in most cases contains very little of embedded foreign constituents, there are frequently found small (a few mm) snow-white grains of f., quite irregular in form; but there are also parts where f. of a more common appearance and colourless occurs in nearly the same quantity as the chiolite, and from there one arrives at the parts, where the two minerals occur in a very fine mixture, and as it seems in a crystallographically orientated intergrowth. This will be described in detail under the chiolite.

The Julianehaab district.

Josva's Copper Mine (Rink). Granular and crystallized together with bornite, epidote etc., sometimes embedded in calcite crystals. Shape dodecahedr l, colour bluish, sometimes intensively dark-blue.

Nunârssuit (Giesecke). Skeleton crystals in arfvedsonite, where the greater part of the substance is washed out, entirely as in the case of the Kangerdluarssuk occurrence.

Qáqaligaitsiaq (Rink). A thin warty coating on fractures in granite.

Panernak at Narssaq (Rosting 1875).

Steenstrup: Tillæg 8 til Rigsdagstidende 1877—78, p. 7.

Steenstrup: M. o. G. 2, 1881, p. 35.

Forms a horizontal mass, up to 1 m thick and consisting of a large-grained aggregate of f. (size of individuals up to 12 cm) with embedded quartz crystals. The colour clear, violet or green with different intermediary shades. In a single cavity violet crystals (up to 6 cm) were found; combination (100), (111), (110); the faces quite dull.

North Siorarssuit (Flink 1897).

Flink: M. o. G. 14, 1898, p. 247.

Colourless octahedrons (up to 5 mm) on epidote crystals in cavities in loose blocks of porphyry, frequently only one in each cavity.

Sagdliaruseq (Steenstrup 1899). Large crystals (up to 10 cm) on rock-crystals in fissures in red sandstone; the colour red- or black-violet; form cubic but the faces incompletely developed. The Greenlanders in Sagdliaruseq presented Steenstrup with a quite colourless cleavage fragment, weighing half a kilogram.

Mussartût (Steenstrup 1899). In fissures in sandstone together with rock-crystals, calcite and small shells of hematite. Irregular masses without crystal form. The colour greyish or dark-violet.

Narssârssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 230.

Flink: M. o. G. 24, 1901, p. 16.

F. is one of the most widely distributed minerals in the pegmatite veins; sometimes it fills the whole of the interval between other minerals, such as zircon, ægirine etc., and it is then violet-red to colourless. Sometimes small crystals (about 5 mm) are found, bluish or greenish in colour; in a few cases they may even attain as much as 25 mm in diameter, and then they have a pure azure colour, which looks very beautiful together with the glittering colourless or rosy albite crystals surrounding them. The dominating form is (110), (100) is smaller and (111) still smaller. Other specimens from this locality are fluorescent, in transmitted light they are violet, but in reflected light they show, at any rate in certain parts and directions, very strong blue colours.

South Siorarssuit (Bøggild 1900).

Bøggild: M. o. G. 25, 1902, pp. 69 and 71.

Found in pegmatite veins in altered nepheline syenite of two different shapes.

1. As crystals on ilvaite and albite where the intervals between these crystals are filled with calcite. The form is very regularly octahedral (up to 1.5 cm), of a clear bluish-green colour.

2. As a coarse-grained mass, filling the interstices between innumerable crystals of albite, ilvaite and green garnet. The colour varies between bluish-green and violet.

Kangerdluarssuk.

Gordon: Proc. Ac. Nat. Sci. Philadelphia 76, 1925, p. 265.

It is recorded that f. is rather common in pegmatite, partly as white dodecahedral crystals (7 mm) on arfvedsonite, and partly as irregular masses or rounded octahedral crystals together with sodalite, ægirine and rinkite.

F. from the pegmatite presents a particularly characteristic phenomenon, it occurs as skeleton crystals of which a few specimens have been found at various times; one of these has preserved f., whereas this mineral is entirely decomposed in the other. The single individual the extent of which may exceed 10 cm, consists of quite thin plates (1 mm or less) which are parallel with the cubic or octahedral faces of the fluorite, so that a fracture parallel with a cubic face shows two right-angled systems of lines forming 45° with each other. These skeletons are nearly exclusively found in arfvedsonite, but may merge slightly with the adjacent minerals. Quite similar skeleton crystals have been found in arfvedsonite from Nunarssuit.

An entirely different form of skeleton crystals is found in the pegmatite veins at Kangerdluarssuk, but it will be most natural to deal with them under the sodalite.

Nunasarnaussaq (Giesecke 20-7-1809). Said to penetrate green-

stone together with siderite and calcite; found in cubes, octahedrons or massive.

Julianehaab (Giesecke 12-7-1806). Here granular f. is mentioned together with lepidolite, which penetrates the granite in various places on the northern side of the settlement. A single sample is fine-grained violet f. in mica schist.

Igaliko (?). As mentioned on p. 58 there is in this place a fluorite-bearing rock of a rather unusual composition i. e. fine-grained f. penetrated by a great number of quartz crystals. The f. individuals are about 0.5 mm in diameter. The quartz crystals may attain a length of 1 mm and a width of 0.1 mm.

Certain parts consist of nearly pure f., whereas the ordinary proportions in others may be inverted, octahedrons of f. being found in quartz. Both minerals contain small masses of phosphorite, but very unequally distributed.

Igaliko Fjord (Rink). Granular masses from a quartz vein together with sphalerite and galena. The colour dull whitish or faintly violet.

East Greenland.

West of Kap Franklin (Rosenkrantz 1929). As a contact formation from dislocated layers of Devonian sandstone a very impure f. is found in the shape of an irregular, fine-grained mass which, however, here and there has a rather indistinct, columnar structure. In a few fissures small cubic crystals are found. The colour is greyish or whitish, in many places rusty.

(Yttrocerite).

(CaF_2 with varying amounts of $(Y,Er,Ce)F_3$).

From Ivigtut Julius Thomsen[1]) mentions a mineral, the chief constituent of which is CaF_2, but which contains a few percentages of Ce and Y etc., and he adds that it rather belongs to the yttrocerite group. As y. contains 20—30 per cent of cerium fluoride, the mineral in question can at most consist of fluorite with a few percentages of y.; there is also a possibility that the cerium may be present in the form of fluocerrite or in other ways, and it will hardly be possible to decide which mineral is meant, before we have succeeded in finding it in such large quantities that it can be mechanically separated from the fluorite.

34. Ralstonite. $(Mg,Na_2)Al_2(F,OH)_{11}2H_2O$.

The Frederikshaab district.

Ivigtut.

Brush: Amer. Journ. Sci. 2, 1871, p. 30.

Nordenskiöld: Geol. Fören. Förh. Stockholm, 2, 1874, p. 81.

[1]) Overs. k. d. Vid. Selsk. Forh. 1898, Nr. 1.

BERTRAND: Bull. Soc. Min. de France, 1881, 4, p. 34.

BRANDL: Sitzber. d. math. phys. Classes, k. b. Akad. d. Wiss. München 1882, p. 118. Annalen d. Chemie 213, 1882, p. 7.

GROTH: Zeitz. f. Kryst, 7, 1883, p. 471.

PENFIELD and HARPER: Amer. Journ. Sci. 32, 1886, p. 380.

BØGGILD: M. o. G. 50, 1912, p. 121. Zeits. f. Kryst. 51, 1913, p. 606.

GORDON: Acad. Nat. Sci. Philad. Notulae Naturae, No. 11, 1939.

R. crystallizes regularly, nearly always in octahedrons, more rarely also with small cubic faces; the faces may be rather glossy, but are always more or less curved. Traces of cleavage parallel to the octahedron. R. is generally colourless, clear and transparent or whitish and semi-transparent, sometimes yellow or brown on the surface. Hardness 4.5; specific gravity of the purest material 2.614.

Optically r. proves to be extremely irregular in structure; in the main it consists of eight pyramidal sectors with their apex in the centre and bases in the octahedral faces and with a positive sign, but in details there are a number of exceptions from this rule; single or double refracting areas may interchange; in some places there may be biaxial areas, and signs and orientations of extinction may vary. The variation of the refraction seems to be unusually strong. The author has determined it at 1.4267, whereas GORDON puts it at 1.399, and by closer inspection of the material I have found all sorts of values lying between those mostly, however, not below 1.41.

Analyses undertaken by NORDENSKIÖLD (1. of 0.22 gr), BRANDL (2), PENFIELD (3) and HARPER (4).

	1	2	3	4
F	50.05[1])	57.12	undet.	39.91
Al.....	22.94	22.14	22.33	24.25
Mg.....	5.52	3.56	4.29	4.39
Na.....	4.66	5.50	4.12	4.27
Ca	1.99	1.53	1.67	0.03
H_2O.....	14.84	10.00	18.41	18.73
K	trace		0.11	0.12
P_2O_5.....	trace			
	100.00	99.85		91.70

It is not possible to deduce any more accurate formula from these mutually very deviating analyses. When calculating from the last analysis which seems to be the most reliable, the formula arrived at is something like $(Mg, Na_2)\ Al_3\ (F, OH)_{11}.\ 2H_2O$, but many other formulas have been put up.

[1]) Of this value which has been found as a remainder, a constituent of 38.13 F and 10.69 O has been computed.

R. is infusible before the blow-pipe; when heated in a glass tube aqueous vapours are produced and with high temperatures vapours, which corrode glasses.

The size of the Greenland crystals is generally 1—3 mm, but many attain as much as 10 mm. It is rarer to find larger individuals (up to 6 cm) extending through a number of connected cavities. The mineral is in most cases closely associated with the thomsenolite crystals, in such a manner that r. is found interspersed among the latter. Both minerals are frequently found together with siderite, quartz, chalcopyrite etc. However, it does not seem likely, as set forth by GROTH, that r. should have been formed directly by displacing the siderite when found in rhombohedral cavities in the latter. Siderite in the fresh cryolite may also have similar cavities with enclosures of this mineral, and it seems the most natural supposition that it is the cryolite, which has subsequently been altered into ralstonite and thomsenolite.

There are, however, in Ivigtut also manners of occurrence for r. which deviate essentially from the typical one given above. Thus fragments may be found consisting of nearly pure, fine-grained r. which, however, in certain places contains a number of quite small embedded thomsenolite crystals. In cavities in this mass are seen numerous incompletely developed crystals of r.

In another case r. is found segregated on the wall of a fissure in a massive prosopite. The crystals are unusually beautiful, but rather small (about 1 mm); on the goniometer the faces, however, prove to be rather curved.

R. was first discovered by Mr. RALSTON of Philadelphia; he sent the material to J. DANA, who gave it to BRUSH to investigate; the latter in his turn named it after the finder, and gave a description and a preliminary analysis of the mineral, the composition of which was, however, only fairly accurately elucidated by NORDENSKIÖLD.

Outside Greenland r. has been found in very small crystals in the American occurrence of cryolite; the form mainly cubic, for which reason it is a little uncertain, whether it is really r.

35. Prosopite. $Ca[Al(F,OH)_4]_2$.

The Frederikshaab district.

Ivigtut. (TAYLER 1885).

BØGVAD: M. o. G. 119, 7, 1938, p. 6.

First observed by KAREN CALLISEN (1927) in a very fine-grained aggregate of p. and thomsenolite. Mentioned by BØGVAD as associated with weberite, fluorite, green mica etc. A more detailed description of these minerals will be given later.

By a revision of the material, it has been possible to find a number

of samples containing larger quantities of p. together with thomsenolite or ralstonite or both. These two minerals can be found scattered in the prosopite, and sometimes the latter may be intergrown in a poikilitic manner in larger individuals of the thomsenolite. On walls of fissures and cavities in the prosopite it is possible to find crystals of the two minerals, though never of p. itself, which always only occurs in aggregates. These are light bluish or greyish in colour and under the microscope prove to be possessed of a very fine-grained structure; the individuals have most frequently a strongly undulating extinction, and in some cases regular spherulites are seen with a positive sign; they are particularly distinct, where the mineral has grown into the almost entirely isotropic ralstonite.

This p. which, it is true, deviates a good deal in structure from other occurrences of the mineral, is determined partly by the refraction, nearly 1.505, and by the hardness, which is evidently greater than in the two other minerals mentioned above. The specific gravity is determined at 2.83, but it is hardly possible to procure a pure material, as besides these minerals there are a number of particles of untransparent material in the p. Only in one instance p. was found in such large individuals that it was possible to trace an interferencefigure, biaxial, positive; the mineral is unfusible before the blow-pipe.

The chemical formula of p. is $CaAl_2$ (F, $OH)_8$, and it is from an older period known from various localities, also from the cryolite occurrence in Colorado. As to the extent of its distribution in the Ivigtut cryolite nothing can be concluded: seeing that the mineral is so little conspicuous, it is only by pure chance that it has been collected together with other minerals.

36. Cryolithionite. $Na_3Al_2[LiF_4]_3$.

The Frederikshaab district.

Ivigtut.

Ussing: Overs. k. d. Vid. Selsk. Forh. 1904, Nr. 1.

Bøggild: M. o. G. 50, 1912, p. 115, Zts. Kryst. 51, 1913, p. 599.

C. crystallizes regularly, and in the Greenland material no other form than the dodecahedron is found. The crystals may attain a rather considerable size (diameter up to 17 cm); they have very incompletely developed faces, but the form is in most cases fairly distinct. The crystals are always completely developed and enclosed by cryolite on all sides C. is upon the whole rather pure; under a microscope small enclosures of air and fluid are seen, also with intermixed small quantities of cryolite (the opposite is never the case), frequently in a kind of graphic-granite connection. Like the surrounding cryolite c. sometimes contains smaller quantities of the common minerals (siderite, sphalerite, chalcopyrite and quartz).

C. is quite clear and colourless; the white colour is particularly striking in the cases where it is embedded in the dark cryolite (fig. 9). There is a distinct dodecahedral cleavage. The hardness is 2.5—3; the specific gravity of the purest material 2.777—2.778. The refraction is exactly as in cryolite (in Na-light 1.339). Analysis by CHR. CHRISTENSEN: Al 14.46, Na 18.83, Li 5.35, F 60.79, loss by ignition 0.36 = 99.79, which corresponds very nearly with the formula: $Li_3Na_3Al_2F_{12}$. When heated c. melts at a temperature of about 710°, or in other words much more easily than the cryolite; when further heated it alters like the

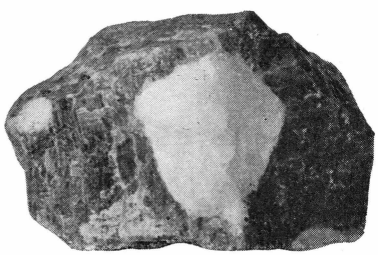


Fig. 9. Cryolithionite in cryolite. c. 1:2.

latter. The dissolubility in water is 1:1350, when the solution is left for some length of time, it crystallizes in the form of small cubes.

The first small fragment of the mineral was found by STEENSTRUP in 1899, but not investigated in details. Not until in 1903 did Mr. EDWARDS, manager of the cryolite mine at Ivigtut, send in a considerable quantity, and since then rather small amounts have been seen; neither has the occurrence been investigated in details. It is said to exist in the south-eastern part of the mine at a depth of 30—40 m.

C. has later on been identified in the older collections from Ural; it seems as if the whole of the material, which is to be found in the different museums under the name of cryolite, consists of an equal mixture of both minerals intergrown.

37. Cryolite. Na_3AlF_6.

The Frederikshaab district.

Ivigtut (formerly also called Evigtok, Iviket etc.).

SCHUMACHER: Nat. Selsk. Skr. 4, 2. Hefte, 1798, p. 230.

ABILDGAARD: Scherer's allg. Journal d. Chemie, 2, 1799, p. 502.

D'ANDRADA: ibid. 4, 1800, p. 38.

ABILDGAARD: K. D. Vid. Selsk. Skr. 1800, 1. Del, p. 311.

KLAPROTH: Journal de Phys. 51, 1800, p. 473. Beiträge zur chem. Kennt. d. Mineralkörper, 3, 1802, p. 207.

Vauquelin: Ann. de Chimie, 37, Anno IX (1801), p. 89.

Hauy: Traité de Minéralogie, 2, 1801, p. 398.

Schumacher: Verz. der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien, 1901, p. 103.

Gillet-Laumont: Journal des Mines, Nr. 470, p. 159.

Jameson: Edinb. Mem. Wern. Soc. 1, 1808—10.

Giesecke 10-8-1809.

Bruun Neergaard: Journal des Mines, 30, 1813, p. 383.

Allan: Thomson's Annal. Phil. 1, 1813, p. 141.

Giesecke: Edinb. Phil. Journ. 1821—22, 6, p. 141. Manual of Greenland, p. 341.

Berzelius: Vet.-Akad. Handl. Stockholm, 1823, p. 314.

Chodnew: Verh. Russ. min. Gesell. 1845—46, p. 219.

Rink: Om Monopolhandelen paa Grønland, 1852.

Hoff: Vid. Medd. Nat. Foren. 1854, p. 201 and 239.

Kenngott: Uebers. miner. Forsch. 1855, 1856, p. 21.

Poggendorff's Annalen 98, 1856, p. 511.

Rose: Zts. d. geol. Gesell. 8, 1856, p. 314.

Tayler: Journ. Geol. Soc. London, 121, 1856, p. 140. Manual of Greenland, p. 348.

Descloizeaux: Annales des Mines, 11, 1857, p. 292, 324.

Goldschmidt: Nord og Syd, 1857, p. 249.

Rink: Grønland, II, S. Insp., p. 140 and app., p. 148.

Deville: Instit. 1859, p. 149. Ann. chim. phys. 61, 1861, p. 337. Ann. mines, 2, 1862, p. 401.

Heintz: Zeits. Gesammt. Naturw. Halle, 18, 1861, p. 133. N. Jahrb. Min. 1862, p. 186.

Schuch: Inaug.-Diss. Göttg. 1862. Ann. Chem. Pharm. 126, 1863, p. 108.

Valløe: Grønland. Danske Folkeskrifter, Nr. 34, 1861.

L. Jakobsen: Et Aar i Grønland, 1862.

Kokscharow: Materialien zur Mineralogie Ruslands, 4, 1862, p. 389.

J. Thomsen: Tidss. Physik og Chemie, 1862, p. 621.

J. Thomsen: Répert. Chimie Appl. 5, 1863, p. 289.

Bluhme: Fra et Ophold i Grønland 1863—64, 1865.

Hagemann: Amer. Journ. Sci. 42, 1866, p. 268.

Quale: Smithsonian Reports, 1866, p. 398.

Websky: N. Jahrb. f. Min. 1867, p. 810.

Descloizeaux: Nouvelles recherches sur les propriétés optiques des cristaux, Paris, 1867, p. 201.

Dana: Mineralogy, 5. Ed. 1868, p. 126.

Haidinger: Jahrb. Geol. Reichs-Ans. Wien, 12, 1868, p. 118.

Rob. Braun: Brit. Assoc. Rep. 41, 1871, p. 94. Transact. Geol. Soc. Glasgow, 5, 1875, p. 55. Manual of Greenland, p. 467.

Krenner: N. Jahrb. f. Min. 1877, p. 504.

Klein: N. Jahrb. f. Min. 1877, p. 808.

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 234.

Noellner: Zeits. d. d. geol. Gesell. 33, 1881, p. 139.

Brandl: Sitzb. d. math. phys. Classe d. k. k. Akad. d. Wiss. zur München, 1882, p. 118, Annalen der Chemie, 213, 1882, p. 3.

Descloizeaux: Bull. Soc. Min. de France, 1883, Nr. 8.

Groth: Zeits. f. Kryst. 1883, 7, p. 375.

Krenner: Math. u. naturw. Ber. aus Ungarn, 1, 1883, p. 161.

Mügge: Jahrb. d. wiss. Anst. zu Hamburg, 1884, p. 67.

Groth: Zeits. f. Kryst. 10, 1885, p. 642.

Holst: Sveriges geol. Unders. Ser. C, Nr. 81, 1886, p. 8.

Baumhauer: Zeits. f. Kryst. 11, 1886, p. 133.

Joly: Proc. R. Soc. London, 41, 1887, p. 250.

Baumhauer: Zeits. f. Kryst. 18, 1891, p. 355, and 24, 1894, p. 87.

Gramont: Bull. Soc. Min. de France, 18, 1895, p. 171.

Will. Ramsay and M. W. Travers: Proc. R. Soc. London, 60, 1896, p. 445.

S. M. Jørgensen: Nyt Tidss. f. Fysik og Kemi, 3, 1898, p. 161.

Tietgen: Illustr. Tidende, 30. Dec. 1900.

Ussing: Danm. geol. Unders. II. Række, Nr. 12, 1902.

Ussing: Overs. d. k. d. Vid.-Selsk. Forh. 1904, Nr. 1.

Mügge: Ctrbl. f. Min. 1908, p. 35.

Nacken: sst. p. 38.

Jarl: Fabrikken Øresund 1859—1909, 1909.

Baldauf: Zts. prakt. Geol. 18, 1910, p. 432.

Steenstrup: M. o. G. 34, 1910, p. 145.

Halland: Mining World Chicago, 34, 1911, p. 689.

Bøggild: M. o. G. 50, 1912, p. 1. Zts. Kryst. 50, 1912, p. 349.

Bøggild: M. o. G. 50, 1912, p. 105. Zts. Kryst. 51, 1913, p. 591.

Wallerant: Bull. Soc. Fr. de Min. 35, 1912, p. 177.

Grünwald: Über Gewinnung und Bedeutung des natürlichen grönländischen Kryolithes. "Sprechsaal" 1914.

Jagd: Ivigtut. Tekn. Foren. Tidss. 46, 1922, p. 55.

Gordon: Engineering and Mining Journal-Press, 1926.

Lichtenberg: Kryolitindustrien. Udg. af Industriraadet, 1935.

Naray-Szabo and Sasvari: Zts. Krist. 99, 1938, p 27.

Bøgvad: Medd. D. Geol. Foren. 9, 1940, p. 561.

O. Lerche: Ivigtut Kryolitbrud. Ingeniøren, 52,. 1943, A, p. 116.

Jagd: Ivigtut til omkring 1920. ibid, p. 120.

In former times there has been a good deal of discussion regarding the crystalline form of the cryolite, but now, as first demonstrated by KRENNER, it is beyond dispute that it is monoclinic and besides pronouncedly pseudo-regular. By far the most common forms which are never absent, and which on many crystals are the only ones are *c* (001) and *m* (110), together forming a figure completely resembling a cube; the prismatic angle is 88°2′, and the angle between *m* and *c* is 89°52′. To this must sometimes be added smaller faces of *v* (101), *k* ($\bar{1}01$) and *r* (011) (fig. 10). In 1899 FLINK collected some specimens with small crystals with especially well-developed faces; here *c* and *m* are not so

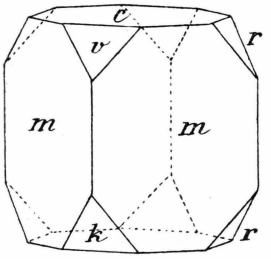


Fig. 10. Cryolite; Ivigtut. (After KRENNER).

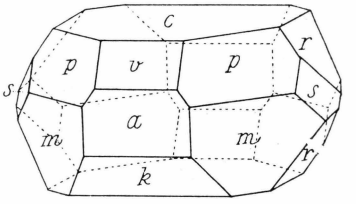


Fig. 11. Cryolite; Ivigtut.

dominating as otherwise, and besides the above-named faces they possess the forms *a* (100), *p* (111) and *s* (121) (fig. 11). In 1908 the Mineralogical Museum of Copenhagen obtained some specimens which were especially rich in faces, and besides the 8 forms mentioned above there were found 10 other forms which, however, possess very small faces. The 18 forms are the only primary ones known in the cryolite, but by translations, which are very easily produced in this mineral, a large lot of secondary faces may be formed which shall, however, not be described here.

There is hardly a single crystal which is not penetrated by twin-lamellae; as to the character of the latter opinions have varied very much; as twin planes are mentioned by WEBSKY (100) and (001), Dana (110), Mügge (112) and 11$\bar{2}$) and KRENNER (110) and (112). Later investigations, however, seem to show that in the crystals there is not a single twin of the common type (with a twin plane), but various others. BAUMHAUER mentions 1. tw. axis [110] revolution 180° and 2. the same axis revolution about 90°; BØGGILD mentions 3. tw. axis the normal to (110), revolution about 90° and 4. tw. axis [111], revolution 180°. Nos. 1 and 2 are the most common and can both be primary and secondary; No. 3 is only secondary, and No. 4 is very rare and primary. In the ordinary coarse-grained c. which is entirely penetrated by a close

network of twinlamellæ, there are besides the mentioned laws 1—3, as far as can be seen, twins with tw. pl. (001), (100), (112) and (11$\bar{2}$), but it has not been easy to identify them with certainty.

Combination striæ are found on the prismatic faces, partly oblique and partly horizontal; the base as a rule is rather plane. Etching figures have been investigated by BAUMHAUER and correspond completely with the monoclinic symmetry.

Opinions vary very much as regards the cleavage, and as cleavage faces are given both (110), (001), (101) and ($\bar{1}$01). According to JOHNSTRUP the crystals possess no trace of cleavage, and this is also undoubtedly correct; the fracture is conchoidal or uneven. On the other hand, the main mass of c. with the coarse-grained structure has a strong parting in three rectangular directions in consequence of the twin lamellæ.

The hardness is 2.5, sp. gr. very close to 3. The lustre is faintly vitreous. C. is most frequently clear and colourless, the large-grained form mostly white and semi-transparent. More rarely the colour is faintly yellowish or brownish, still more rarely reddish; a few patches are dark-grey, sometimes almost quite black.

C. is optically positive; the axial plane is at right angles to *b* (010), the acute bisectrix forms an angle of 43°54′ with the *c*-axis; the axial angle in the air is about 60°; the refraction is α 1.3385, β 1.3389, γ 1.3396; the double refraction is consequently extremely faint (0.0011). The refraction is nearly like that of water (1.333), for which reason a clear fragment of c. is nearly invisible in water; in the same manner quartz crystals in the impure c. can be made visible by putting the fragment into water, so that c. becomes more transparent.

Analyses by BERZELIUS (1), CHODNEW (2), DEVILLE (3), HEINTZ (4), SCHUCH (5), BRANDL (6—8), JARL, in BALDAUF (9). Nos. 1 and 4 are undertaken on granular c. No. 6 on a yellow mass between the latter and the crystals, and Nos. 7 and 8 on the crystals themselves.

	1	2	3	4	5	6	7	8	9
F	[54.07]	[53.23]	[55.55]	[53.36]	[53.10]	54.28	54.37	54.15	53.90
Al	13.00	13.23	12.75	13.90	13.00	13.01	13.00	13.07	12.80
Na	32.93	32.71	31.70	32.56	33.90	32.41	32.27	32.56	32.70
	Mn_2O_3 + MnO	0.83		Ca. 0.11				H_2O	0.40
				Mg. 0.07					
	100.00	100.00	100.00	100.00	100.00	99.70	99.64	99.78	99.80

All analyses agree very well with the formula Na_3AlF_6, the theoretical composition of which is F 54.29, Al 12.86, Na 32.85.

When the cryolite is heated, the angles of the crystals more and more approach the regular ones, and at about 500° the crystal has become regular and the double-refraction has disappeared. When heated

a little below this temperature numerous twinlamellæ are formed; when heated to more than 500° and then cooled off, such an infinitude of small lamellæ are formed that the crystal appears regular, even though these lamellæ can be observed under the microscope. Ussing determined the melting point at 920°; the melted mass, when further heated, very quickly gives off both NaF and HF, and Al_2O_3 is left. According to Ussing c. is soluble at an ordinary temperature in 2730 parts of water.

The cryolite occurs in a large, irregularly formed mass immediately at the southern side of Arsuk Fjord. The surface originally consisted of an elongated area, almost on a level with the sea; the length was about 155 m, the width about 30 m. From the south-western part there was a branch towards northwest, which later was covered at high tide. When the mass is being worked, it turns out that it becomes thicker, the farther down one gets, at least to a certain depth, the south-eastern wall sloping strongly down under the rock, whereas the northern wall is vertical. In more recent times an attempt has been made to determine the whole mass of the bed by means of borings, but no farther details are known about the result.

The greater part of the cryolite mass consists of a very coarse-grained aggregate with very varying sizes of grains, in which various minerals have been intermixed in varying quantity. The most common percentage of admixtures seems to be about 10 per cent, the minerals being siderite, quartz, sphalerite, galena, chalcopyrite, pyrite etc., nearly arranged after their frequency. There are also areas of entirely pure c., which in that case may occur in extremely large (several metres) individuals, but on the other hand there are areas, where the minerals mentioned are heaped up in such large quantities that they form coarse-grained masses with very little c. The crystals are frequently found in fissures in the cryolite mass, nearly always in such a manner as to form a continuation of the underlying polysynthetic individual in the granular mass, for which reason they often have a parallel orientation over longer distances. Only the above-mentioned crystals collected by Flink are placed in quite a different manner i. e. at random in cavities, more especially on siderite. Here and there in the cryolite massif there are fissures and cavities with other fluorides, such as thomsenolite, pachnolite, ralstonite and geararksute, often collected in larger amounts which seem to have been produced by the alteration of the cryolite. In certain parts there are also large quantities of chiolite, cryolithionite and, furthermore, a few rarer fluorides.

Most of the crystals are rather small, and the length of their edges amounts to about 1 cm, though they may frequently be a good deal larger, viz. something like 4—5 cm. Essentially larger crystals (about

8 cm) can, however, be found, but in a peculiarly altered state, the outer face being altered to pachnolite, whereas the interior is hollow. Also the large polysynthetic individuals may be altered in a corresponding manner, in that they form a dense network of thin walls of pachnolite with a right-angled orientation. In both cases numerous quite small pachnolite crystals project into the cavities. These formations are probably produced by the pachnolite having penetrated into small fissures in the cryolite, after which this mineral has been dissolved;

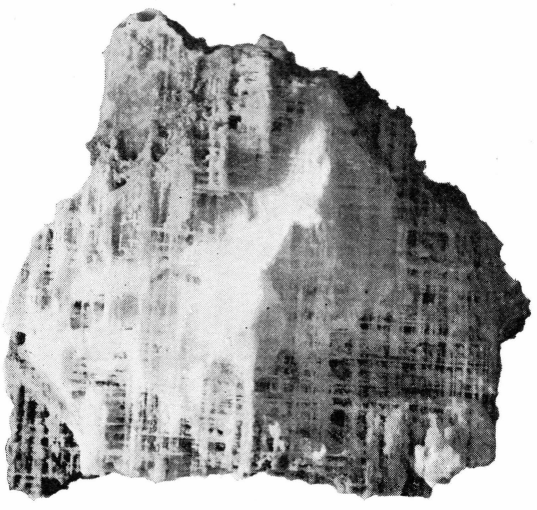


Fig. 12. Relict structure of cryolite. c. 2:3.

a few remainders of c. are, however, preserved in these formations. This is seen in fig. 12, which shows a relict structure after cryolite with a rest of fresh cryolite in the middle.

A peculiar colour phenomenon in the white c. has been mentioned by STEENSTRUP, viz. some small rosy to pale-violet spots, where c. has been exposed to blows or explosions. C. is crushed in the place where the colour is to be found, and under the microscope there is absolutely nothing to be seen. The colour is entirely insensible to light and is not influenced by weak acids, alcohol or ether. Any explanation of the phenomenon it has up to the present not been possible to give.

The dark c. containing the red fluorite is mentioned under this mineral; it appears rather like a ribbon through the white c. But also dark c. occurs under quite different conditions, where it is unaccompanied by fluorite. Thus black c. is frequently found in the pegmatite outside the cryolite mass, being generally still darker than the one previously mentioned, which f. i. may be found as thicker or thinner veins in the light-coloured microcline or as a brecciated mass, which may

greatly resemble graphic granite (fig. 13). Besides c. smaller quantities of quartz or siderite enter into the same mixture, either forming independent veins or being found in the same veins as c., in which case the filling-out may consist of the three minerals interchanging with each other. Furthermore, as pointed out by BØGVAD, the dark c. is found as a mantle round the fragments of granite or greisen, which have fallen down into c., and at a short distance from the fragment

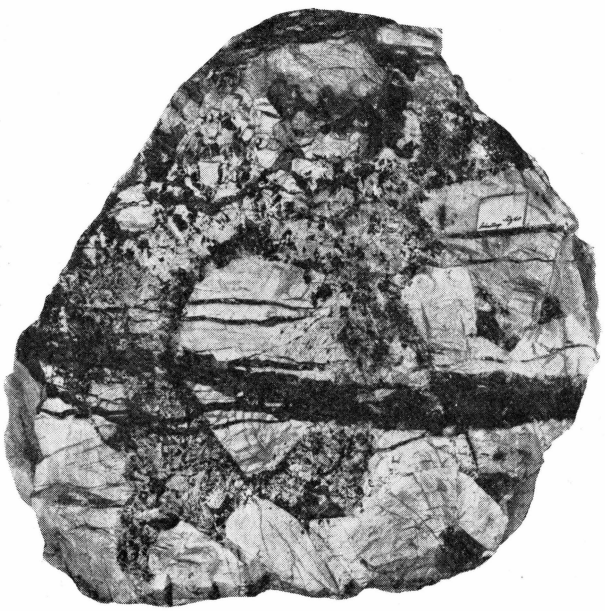


Fig. 13. Microcline and black cryolite. c. 2:7.

this colour passes quickly into white. A corresponding colouring of the white c. can be produced by melting the mineral together with fragments of the greisen. Thus, it seems that there must be various reasons for the occurrence of the dark c.

Surrounding the main mass of c. there is another zone, which contains smaller quantities of c. but mainly consists of quartz and felspar, besides the ores mentioned and a number of other minerals such as ivigtite, cassiterite, columbite, molybdenite and others. More particularly towards southwest this area attains a very great thickness (up to about 30 m). The pegmatite is generally very loose, possibly because c. may have been washed out of it, and the various minerals occur with rather well-developed crystal forms.

Immediately outside this area there is a mantle some metres thick, consisting of granite or greisen, sometimes brecciated; many larger or smaller fragments of this rock have become embedded in the cryolite

mass. The entire occurrence is surrounded by gneiss, which occupies the whole of this part of south-western Greenland. The gneiss is penetrated by numerous diabase veins, none of which, however, enter the cryolite mass, which must thus be more recent.

The mineral is first mentioned (under the name of barite) by SCHUMACHER; ABILDGAARD proved that it contained Al and F, and D'ANDRADA called it by the name it still bears (cryolite = ice stone). In the beginning it was extremely expensive, and it was not until GIESECKE had visited the place, and after his collections had been brought home that it became more common. Until 1849 the mineral had no practical importance, but in that and the immediately succeeding years JUL. THOMSEN made the discovery that it could be used for the production of sodium carbonate, aluminium and other things, and gradually the regular working of the mine was organized. This work was undertaken by the limited company "Kryolith Mine og Handels Selskabet", in Copenhagen; the raw ore is partly carried to the manufactory "Øresunds Chemiske Fabriker" in Copenhagen, partly to America. In the "Øresund" (established in 1859) a cleaning of the material is undertaken by means of many complicated processes, and then the refined product is sent out into the world. At first c. was chiefly used for sodium carbonate, but this industry gradually declined and ceased in 1894. In more recent years about 60 per cent is used for the production of aluminium, 30 per cent for enamel and 10 per cent for alabaster glass; it is now also beginning to be used as a means of protecting plants against insects.

The yearly output of cryolite has varied greatly in the course of years. In the years immediately before the last war it had risen to about 50.000 tons; the total output can be estimated at about 1.5 millions tons. The c. is worked in an open mine, 200 m in length, 40—100 in width and up to 60 m deep. A view of the mine is seen in fig. 14.

Outside Greenland c. has been found in smaller quantities in granite veins at Saint Peters Dome, Colerado, and in Ilmen Mountains in Ural; furthermore, in quite small quantities in Yellowstone Park and in Aragonia. Recently formed c. has been found in rather large quantities in the iron-bearing fur, which originates from the time when cryolite water was still used to fill the boilers. The crystals which may attain a size of up to 1 cm are formed like imperfectly developed cubes with small octahedral faces, and most frequently they also have a very irregular internal structure; only a few smaller crystals can with a fair degree of accuracy be proved to form twins with [110] as tw. axis. Together with these crystals small chiolite crystals have been found and also regular crystals (110), very small, but well-developed. It has not been possible to undertake a more detailed investigation.

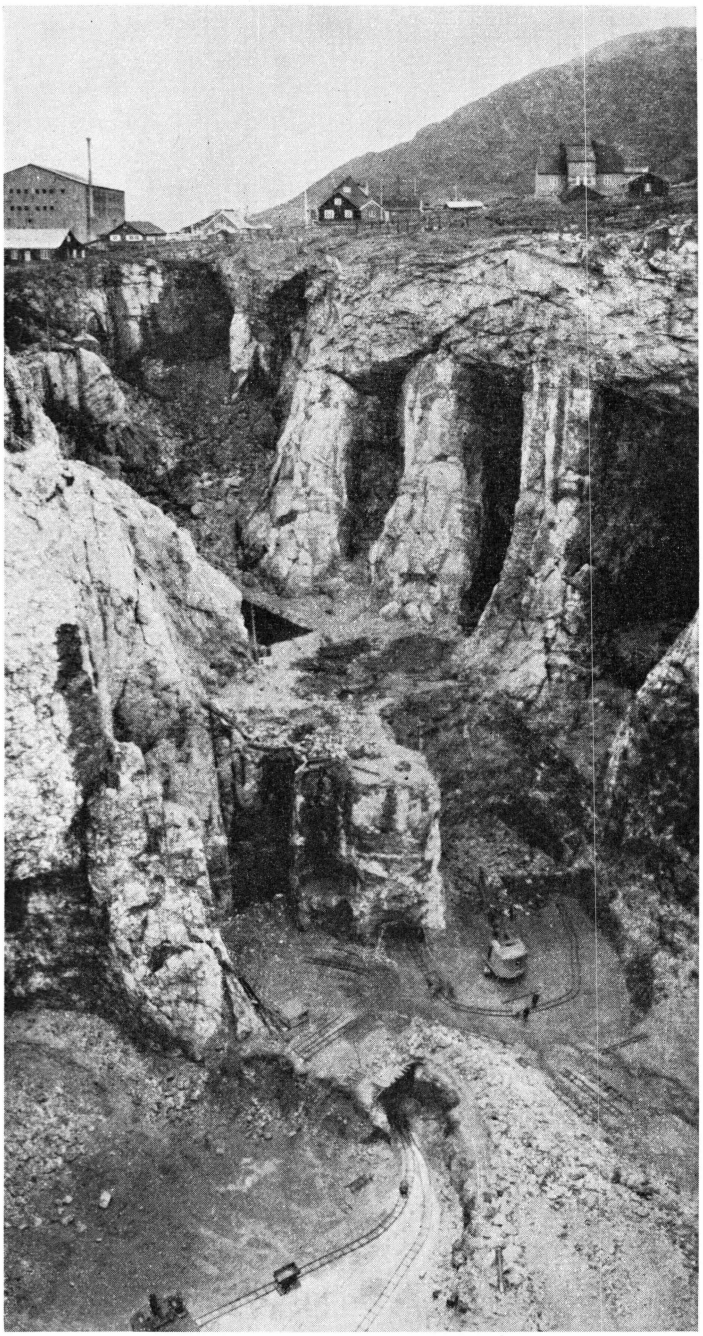


Fig. 14. View of the Cryolite Quarry looking east (1937). At the southern-side we see pillars of cryolite, which have been left in place to support the roof. Below them we see an entrance to a tunnel. (After Bøgvad).

38. Chiolite. $3Na[AlF_4] \cdot 2NaF$.

The Frederikshaab district.

Ivigtut.

HAGEMANN: Amer. Journ. Sci. 42, 1866, p. 93.
GROTH: Zts. f. Kryst. 7, 1883, p. 479.
KRENNER: Math. u. naturwiss. Ber. aus Ungarn, 1, 1883, p. 170.
NORDENSKIÖLD: Geol. Fören. Förh. Stockholm, 8, 1886, p. 172.
BØGGILD: M. o. G. 50, 1912, p. 112. Zts. f. Kryst. 51, 1913, p. 596.
CLAUSEN: Zts. f. Kryst. 95, 1936, p. 394.
BROSSET: Dissertation, Stockholm, 1942, p. 89.

C. crystallizes tetragonally, but in Ivigtut it is only found as irregularly bounded grains. Perfect cleavage along the base, somewhat fainter along a pyramid, the angles of which strongly approach the octahedron. C. is colourless and transparent. The hardness is 3.5—4, the specific gravity very nearly 3. The refraction is: $\omega = 1.3486$, $\varepsilon = 1.3434$.

Before 1908 the only form of the mineral known from Ivigtut was that, which at first was called arksutite and consists of a grained mass of preponderating c. with smaller quantities of fluorite, pyrite and thomsenolite. Analyses have been undertaken by HAGEMANN (1), LINDSTRØM (in NORDENSKIÖLD 2 and 3). No. 2 a was undertaken on the strength of the total aggregate; No. 2 b is computed from No. 2 a, CaF_2 and Fe being deduced; No. 3 is undertaken on the isolated c.

	1.	2a.	2b.	3.
F	51.03	57.22	57.74	57.16
Al	17.87	16.57	17.68	17.28
Na	23.00	22.95	24.49	24.72
Ca	7.01	3.17	—	0.22
Mg	—	0.11	0.11	0.05
Fe	—	0.12	—	—
Loss by ignition	0.57	—	—	—
Insoluble	0.74	—	—	—
	100.22	100.14	100.02	99.43

The two latter analyses agree very well with $Na_5Al_3F_{14}$, which have been computed for the Ural mineral, and which theoretically require F 57.7, Al 17.5, Na 24.8. When heated the mineral melts even more readily than cryolite, but otherwise it reacts like the latter.

The mineral from Ivigtut is first mentioned by HAGEMANN, who called it arksutite after the old name of Arsuk. GROTH proved that HAGEMANNS analysis cannot be correct, as it contained too little F, and he is of the opinion that the mineral is a mixture of cryolite and pachnolite produced by the alteration of cryolite. It was not until the

pure material was analyzed that the mineral proved to be identical with chiolite.

When Ussing was in Ivigtut (1908), he was given some samples of c. in very large crystal individuals, and later on such immense amounts of this mineral have come to hand that there is hardly any other mineral, with the exception of cryolite which is to be found in such large quantities in the Mineralogical Museum of Copenhagen. The new c. was found at a depth of 60 m and very far from the old mine, where the arksutite was found, so that the two occurrences can hardly have had any association with each other. A distinction may be made between two forms of the mineral, one of which is nearly pure, whereas the other one is greatly mixed with fluorite.

1. To this section belongs the greater part of the material, blocks of a very different size, up to 1 m in diameter and with individuals up to 2 dm. In smaller fragments the mineral is quite clear and transparent, in larger white, and there is no trace of dark or other colours. Besides the common cleavage faces mentioned above we sometimes find a cleavage (or something resembling it) parallel with the prism (110). It is a characteristic feature of the cleavage planes that they are very strongly curved, more than seems to be the case with any other substance, sometimes actually folded; it is therefore rather impossible to measure them, and only in quite a few cases fairly accurate values can be obtained. Freely developed crystals have never been found in the Greenland c., with the exception of a few and imperfectly developed ones, which are found separated as new formations in the boilers at Ivigtut. The here mentioned c. is extremely pure, generally so free from foreign admixtures as is rarely seen in fragments of minerals of that size. The most commonly occurring foreign mineral is a number of quite small (frequently less than 1 mm) pyrite crystals; but no trace is seen of all the numerous other minerals found in the cryolite and also in the cryolithionite. Only once in a while small patches of fluorite of a rather loose consistency are found, and finally it must be borne in mind that here it is possible to find the new mineral metajarlite, easily perceptible because of its grey colour.

2. In certain areas of the pure c. with a rather abrupt transition to the surroundings a special type of c. occurs, which is closely interspersed with fluorite grains, found in such quantities that they make between a third and half of the whole mixture. Here a distinction may again be made between two very different forms.

a. In a comparatively large chiolite individual there are numerous grains of fluorite, greatly varying in size, though mostly in the dimension 0.5—3 mm. These grains have, as far as can be seen, no crystallographic orientation, it being a case of a kind of poikilitic structure.

b.[1]) In certain of these associations, particularly in such as have the smallest fluorite grains, the two minerals are orientated with the crystallographic axes in parallel positions, viz. the octahedral faces of the fluorite, as far as possible parallel with the pyramid of the chiolite (111), which can be done, because the angles of the latter do not deviate very much from the octahedral angle; in the case of the angle of the chiolite: (111): $(1\bar{1}1) = 71°37'$, (111): $(11\bar{1}) = 68°20'$, whereas the octahedral angle, as is well-known, is 70°32′. Thus whitish opaque formations are produced, which cleave into very regular octahedrons with flat, but very dull faces; that the fluorite is orientated parallel with the chiolite can, it is true, not be directly observed, but it may be concluded, partly from the fact that the faces, when seen in reflected light under the microscope, do not show any interruption, although the two minerals are mixed in equal quantities, partly from the perfect cleavage, which is far greater than that of the chiolite; there is not the least trace of cleavage of the latter along the base. But then it further happens that the chiolite individuals occupy three different positions, with the main axes parallel with the three octahedral axes, the individuals being comparatively large, up to 1 cm or more. In order to find the proportion between the two minerals, I have determined the sp. gr. as 3.046 (3.042—3.048); for fluorite it is 3.15, for chiolite, 3.00 which yields a percentage of fluorite of about 31; a Ca-determination undertaken at the "Øresund", however, yielded 40—45 per cent of fluorite.

The boundary of the chiolite mass, as far as can be seen, always consists of cryolite; in the latter the common embedded minerals begin to occur, but it is a particularly characteristic feature that on the boundary towards chiolite there are particularly large quantities of topaz, which mineral does not seem to occur in the chiolite, whereas on the other hand the fluorite (with a single exception, p. 66) is not found in the cryolite.

The mineral was first described from Ural in 1846 and was given its name, which means snowstone, because of its likeness to cryolite. The Ural occurrence seems to be rather insignificant compared with the Greenland one.

39. Jarlite-Metajarlite. $NaSr_3Al_3F_{16}$.

Ivigtut. The Frederikshaab district.

Bøgvad: M. o. G. 92, No. 8, 1933.

Brosset: Dissertation, Stockholm, 1942, p. 106.

1. Jarlite.

In 1929 a new mineral aggregate appeared, which seems to be

[1]) The first determination of fluorite in these crystals was undertaken by R. Bøgvad.

among the most interesting as yet found in this peculiar locality. It is a large material of columnar aggregates, the most prominent mineral of which is barite in thin crystals, several cm long, and containing thomsenolite, fluorite, topaz and other minerals; among these is found a new mineral, which Bøgvad for the time being characterizes as "mineral x", and which has as yet not been described. In cavities in this mass small crystals of jarlite occurred, together with thomsenolite. The crystals of j. are very small (about 1 mm long) and have therefore been rather difficult to determine; it has, however, proved that they are monoclinic, elongated parallel with the *b*-axis with the faces (100), (001), ($\bar{1}01$), (110), (010). The crystals are colourless or brown owing to a thin crust of rust. The hardness is estimated at 3—4. The specific gravity is estimated at 3.93, but it is difficult to determine it accurately, owing to the large amount of air bubbles contained in this mineral.

Most of the crystals are optically positive, and the acute bisectrix forms an angle of 16° with the normal to (100). The axial angle is 78—80°; other crystals have in nearly the same place an obtuse bisectrix with 2V c. 92°, and may possibly belong to the metajarlite. Indices of refraction are: $\alpha = 1.427$, $\beta = 1.432$—1.433, γ 1.435.

Analysis by Dr. R. Blix: H_2O below 105° 0.08, H_2O above 105° 1.54, i. e. OH 2.91, F 43.23, Li 0.08, Na 3.23, Mg 0.90, Ca 0.55, Sr 35.60, Ba 0.99, Al 12.16, Fe 0.17 = 99.90. This composition corresponds well with the formula $NaSr_3Al_3F_{16}$, which requires Na 3.43, Sr 39.17, Al. 12.11, F 45.29.

Before the blow-pipe the mineral easily melts, showing effervescense.

The columnar aggregate in which j. has been found *in situ* is observed at different localities in the cryolite mine, chiefly in the western part at a level of $\div$ 55—$\div$ 60 m, partly in a dyke-like formation and partly in adjoining areas, where j. occurs in association with violet fluorite and black cryolite.

The mineral is named after Mr. C. F. Jarl, Director of "Øresunds Chemiske Fabriker" in Copenhagen.

2. Metajarlite.

All the essential properties are naturally the same as in the jarlite, but on the other hand the two minrals are so different, both in appearance and manner of occurrence, that it may be natural to treat them separately, as long as there are no intermediate forms.

The mineral occurs exclusively in a fine-grained form, as inclusions in chiolite, which may attain rather considerable dimensions (about $20 \times 20 \times 10$ cm). The boundaries between the individual grains are rather irregular and indistinct, the grains are elongated and fan-shaped and possess an undulating extinction. The colour is grey.

The hardness is 4—4.5, the specific gravity 3.78, the refraction 1.432. The optic axial angle is very nearly 90°; thus it is difficult to determine the sign, but it seems to be positive. The crystal system cannot be determined.

The analysis has been undertaken by Blix: H_2O below 105° 0.08, H_2O above 105° 1.14 i, e. OH 2.14, F 45.50, Li 0.04, Na 3.54, Mg 1.38, Ca 3.20, Sr 28.70, Ba 2.25, Al 12.49, Fe 0.31 = 99.63. The formula as that of the jarlite, excepting that part of Sr has been replaced by Ca, Mg and Ba. Reaction to heating the same as that of the jarlite.

M. has not been found *in situ* in the mine, but partly in material brought home, partly in boring cores, which shows that it is situated at the western end of the mine at Kote ÷ 35. It is only found in chiolite, which mineral, as already mentioned, is unusually free from foreign minerals, and m. is here very striking, owing to its grey colour as against the snow-white chiolite. The boundaries between the two minerals are very irregular and are frequently accompanied by other minerals such as cryolite, fluorite, topaz and pyrite.

40. Weberite. Na_2MgAlF_7.

The Frederikshaab district.

Ivigtut.

Bøgvad: M. o. G. 119, No. 7, 1938.

Brosset: Dissertation, Stockholm, 1942, p. 94.

Byström: Arkiv. kemi. min. och geologi, Stockholm, 18 B, No. 10, 1945.

W. does not occur in a crystallized form, but judging from the cleavage directions Bøgvad was rather of the opinion that it must be monoclinic; however subsequent Røntgen-investigations have shown that it is rhombic. It is true that there are no cleavage planes visible on the outsides of the fragments, but they occur in the sections, and two of these seem to be more powerful than the rest, forming an angle of 72° with each other and being at right angles to a third and fainter cleavage direction. The colour is grey.

The hardness is 3.5; the specific gravity is determined at 2.96, but it is possibly in reality much greater, as the substance is rather impure with a great number of gas-enclosures. The optic axial plane is parallel to the symmetry plane; the acute bisectrix forms angles of 33 and 39°, respectively, with the two above-mentioned cleavage directions; the axial angle, 2V, is 83°; the sign is positive. The refraction indices are determined at $\alpha = 1.346$, $\beta = 1.348$, $\gamma = 1.350$.

Analysis undertaken by H. Buchwald: Al 11.65, Fe 0.37, Ca 0.08, Mg 10.43, Na 19.08, K 1.19, F 57,58 remainder 0.16 = 100.54. This

agrees very well with the formula Na_2MgAlF_7, which requires Al 11.71, Mg 10.56, Na 19.97, F 57.76.

Before the blow-pipe this mineral turns white and swells up, but does not melt. On heating in a closed tube, a small quantity of white sublimate is deposited, while acid vapours are given off, and the glass is corroded.

W. has been found in a number of different localities in the cryolite mine, but most of these only in small quantities, so that they are only to be discovered under a microscope and by means of an immersion liquid; in other localities rather large fragments can, on the other hand, be found. It is always accompanied by fluorite, cryolite, topaz and pyrite, mostly also by chiolite and green mica, but it can also be found accompanied by a number of other minerals.

The mineral is named after Mr. THEOBALD WEBER, who in 1859 established the factory "Øresund" and played a great part in the development of the cryolite industry.

41. Gearksutite. *$CaAl(F,OH)_5,H_2O$.*

The Frederikshaab district.

Ivigtut (GIESECKE 10-8-1809).

J. THOMSEN: Tidss. Physik og Chemie, 1862, p. 328.

DANA: System of Mineralogy, 1868, p. 130 (communication of HAGEMANN).

GROTH: Zeits. f. Kryst, 7, 1883, p. 481.

FLIGHT: Journ. Chem. Soc. 43, 1883, p. 140.

NORDENSKIÖLD: Geol. Fören. Förh. Stockholm, 7, 1883, p. 684.

CROSS and HILLEBRAND: Amer. Jour. Sci. 26, 1884—85. Bull. U. S. Geol. Survey, No. 20, 1885.

BØGGILD: M. o. G. 50, 1912, p. 125. Zeits. Kryst. 51, 1913, p. 610.

LARSEN and WELLS: Proc. Nat. Acad. Sci. U. S. A., 2, July 1916, p. 360.

G. is a loose earthy mass which, when wet, has an almost fatty consistency; under the microscope it can just be seen to consist of fine needles which in the Greenland material attain a length of about 0.02 and a thickness of 0.002 mm, but from the other occurrences they are somewhat larger. The specific gravity is by LARSEN and WELLS found to be 2.768, and the same authors have determined the indices of refraction: $\alpha = 1.448$, $\beta = 1.454$, $\gamma = 1.456$. The crystals are probably monoclinic; there is an obliquity of extinction of until 16°, the needles are positive in the longitudinal direction. Analyses have been made by HAGEMANN (1), LINDSTRÖM (2, in NORDENSKIÖLD) and by FLIGHT (3, only partial).

	1.	2.	3.
F	41.18	41.81	—
Al	15.52	15.37	16.23
Ca	19.25	21.02	22.39
Na	2.46	1.06	0.43
H_2O	20.22	15.03	—
Fe	—	0.30	—
Mg	—	0.16	—
K	—	0.23	—
O	—	[4.82]	—
Cl	—	0.20	—
	98.63	100.00	—

Lindström's analysis almost entirely agrees with one which has been undertaken by Cross and Hillebrand upon American material, and it leads to the formula $CaAl(F, OH)_5$, H_2O, which in theory requires F 42.9, Al 15.1, Ca 22.4, H_2O 15.1, O 4.5 (if F:OH = 2:1). Hagemann's analysis can hardly be quite correct, as there cannot be sufficient OH + F to saturate the metals, even if the whole of the remainder (1.37 %) is computed as O.

G. melts easily before the blow-pipe and turns into a white enamel; when heated in test tubes it first gives off neutral vapour, but when more strongly heated the glass is corroded; it is easily dissolved in acids.

G. is mostly found in small cavities in the cryolite and the other minerals occurring together with it, and in particular often together with pachnolite and thomsenolite; it must presumably be an alteration product of these minerals. It is possible to find large continuous masses of g., weighing several kg with embedded siderite, quartz and other minerals, so that the cryolite may be supposed to have been transformed *in situ*.

A mineral, which was described by Flight under the name of evigtokite has been proved, by Cross and Hillebrand, to be identical with g.

G. was probably first observed by Giesecke, who speaks of "Steinmark" or "erdige Steinart"; this might perhaps be hagemannite, but it is as a rule very hard. The description by Jul. Thomsen is more accurate; he mentions a white clayish layer in cryolite, consisting of fluoraluminium and fluorcalcium. The name g. is given by Dana at the suggestion of Hagemann, from whom he had received the material; the name is formed from the Greek word "ge", which means earth and arksutite (= chiolite), in its turn derived from Arksut, the old manner of spelling the locality now called Arsuk. The mineral preserves in this way the old term for the locality.

Outside Greenland g. has been found in the American and Russian cryolite occurrences.

42. Pachnolite. $AlF_3,NaCaF_3,H_2O$.

The Frederikshaab district.

Ivigtut.

Knop: Ann. d. Ch. u. Pharm. 127, 1863, p. 61. Bull. Soc. Chim. Paris, 1864, p. 138. Amer. Journ. Sci. 1866, p. 119.

G. v. Rath: Sitzber. Niederrhein. Gesell. Naturkunde, Bonn, 8. Juli 1863. Verh. Nat. Verein, pr. Rheinl. 20, 1863, pp. 140, 144.

Brush: (Comm. of Hagemann) Amer. Journ. Sci. 41, 1866, p. 119.

Wöhler: Nachr. Gesells. Wiss. Göttingen 1875, Nr. 23. N. Jahrb. f. Min. 1876, p. 58.

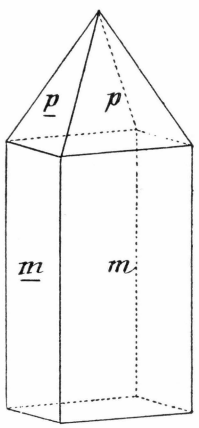


Fig. 15. Pachnolite, twin crystal. (After Krenner).

König: Proc. Acad. Nat. Sci. Philad. 1876, p. 42. N. Jahrb. f. Min. 1876, p. 662.

Knop: N. Jahrb. f. Min. 1876, p. 849.

Krenner: N. Jahrb. f. Min. 1877, p. 504.

Klein: N. Jahrb. f. Min. 1877, p. 808.

Kokscharow: Materialien zur Mineralogie Russlands, 8, 1878, p. 425.

Descloizeaux: Bull. Soc. Min. de France, 5, 1882, p. 310.

Brandl: Sitzber. d. math. phys. Classe d. Akad. d. Wiss. München, 1882, p. 118. Annalen d. Chemie, 213, 1882, p. 5.

Groth: Zts. f. Kryst. 7, 1883, p. 457.

Krenner: Math. u. naturw. Ber. aus Ungarn, 1, 1883, p. 166.

Cross and Hillebrand: Amer. Journ. Sci. 26, 1883, p. 276. Bull. U. S. Geol. Survey, No. 20, 1885.

Bøggild: M. o. G. 50, 1912, p. 116. Zts. Kryst. 51, 1913, p. 601.

Bøggild: M. o. G. 50, 1912, p. 177. Zts. Kryst. 51, 1913, p. 614.

Ferguson: Trans. Roy. Soc. Can. 40, IV, 1946, pp. 11—25.

P. has a monoclinic crystallization; most common is the prism *m* (110) with 98°36′ and the pyramid *p* (111), often also with base (001);

rarer are various steep pyramids, which for that matter are not easily distinguishable from each other. The crystals are always twins along (100), where the appearance becomes perfectly orthorhombic (fig. 15); if there is a base, the twin formation appears as faintly projecting or re-entrant on it.

Nearly no cleavage. The fracture is uneven. The hardness is 3, the specific gravity 2.93—3.0. As a rule colourless and transparent. Optically positive. The axial plane is normal to (010); the acute bisectrix forms an angle of 68°5′ with the *c*-axis. The axial angle 2 E is about 120°. Refraction indices: $\alpha = 1.411$, $\beta = 1.413$, $\gamma = 1.420$.

Analyses have been undertaken by KNOP (1), G. v. RATH (2—3), HAGEMANN (4) and KÖNIG (5); furthermore, on the stalactitic p. by HAGEMANN (6) and KÖNIG (7).

	1	2	3	4	5	6	7
F	50.79	[48.45]	[47.66]	51.15	51.54	[44.58]	51.94
Al	13.14	13.46	12.93	10.37	12.50	12.22	13.16
Ca	17.25	18.10	17.99	17.44	18.17	16.94	17.07
Na	12.16	10.63	12.06	12.04	10.23	15.42	7.35
H_2O	9.60	9.36	9.36	8.63	8.19	8.38	9.40
	102.94	100.00	100.00	99.63	100.63	Fe 0.66	98.92
						insol. 1.80	
						100.00	

The analyses agree with the formula $NaCaAlF_6 . H_2O$, the theoretical composition of which is F 51.39, Al 12.17, Ca 17.99, Na 10.36, H_2O 8.09.

When heated in test tubes p. decrepitates violently, while a white coating is deposited and water given off; it melts very easily. Structural and geometrical crystallographic data are given by FERGUSON and the reader is referred to his treatise, where the corresponding data for thomsenolite are also given.

P. is found in Ivigtut in three different forms:

1. The ordinary, freely developed crystals occur in cavities, nearly always together with and on thomsenolite crystals. The habit of the crystals is rather alike for the two minerals, but if they are fairly large, it is easy to distinguish them from each other, partly because thomsenolite has a perfect cleavage parallel with the base, which p. is lacking, partly because the prismal angle of t. is nearly 90°; whereas the angle of p. deviates about 10° from it. If the crystals of p. are small, it is difficult to observe them in these respects, and they must then be studied under the microscope, where one cannot avoid noticing the never failing twin formation of p. In most samples found in the various collections the crystals are very small (length 1—2 mm, width less than

0.1 mm), for which reason KNOP gave them the name signifying "rime-stone". Gradually, however, numerous larger crystals have been brought to light (up to 15 × 3 mm), but the largest of them are very imperfectly developed. The cavities in which p. and thomsenolite are found, may be quite irregularly shaped, but they are frequently bounded by smooth surfaces as mentioned under cryolite.

2. To this class belongs a fairly large material, which was collected by the author in 1900 at the most easterly end of the mine; it is difficult

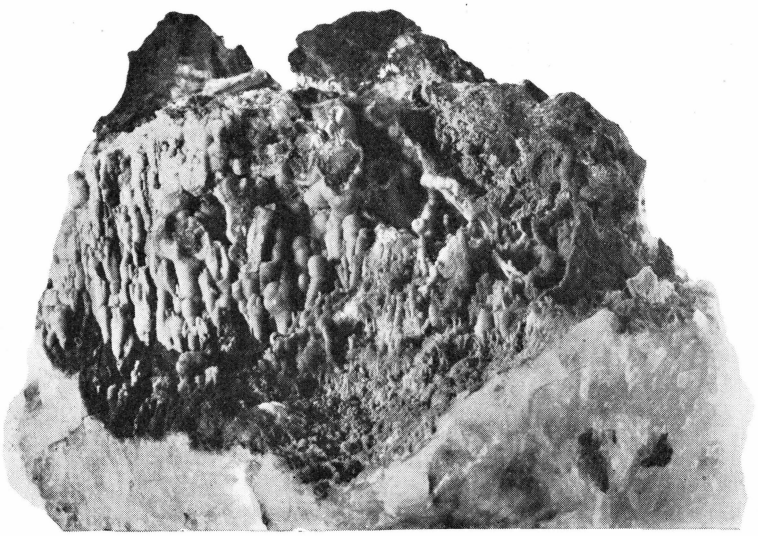


Fig. 16. Pachnolite, stalactitic. c. 1:2.

to say how universally distributed it is. There is not much to induce collectors to be on the lookout for these samples, as they look very insignificant, in spite of the crystals not being so very small. The peculiar thing is that the crystals of p. are overgrown with thomsenolite so that, as contrasted with what is the case under ordinary conditions, this mineral must be the last formed. These conditions have been described in the first of the author's treatises mentioned above, and here only a few principal points will be recorded. On the sides of a single pachnolite crystal, as usual twinned on (100), the thomsenolite crystals are orientated in two different ways, though in such a manner that the crystals are always recumbent i. e. their *c*-axes are at right angles to that of p. But in the former case their base is grown fast to the face *m* (110) of p., in the latter to a prismal face, and in this so-called II type p. is as a rule entirely embedded between the thomsenolite crystals, so that it is not visible from the outside.

3. This group, the stalactitic p., is in all respects very different from the others; there are no visible transformation processes in the

cryolite, at most an erosion of the surface, before p. was deposited; the latter is not only found on the cryolite, but also on quartz, siderite and other minerals. As to the occurrence no details are known, only that they must originate from the older mine (from about 1870). The stalactites can attain a length of about 2 cm and a width of 0.5 cm; the colour is brownish; they resemble chalcedony stalactites in that they are apt to curve in different directions (fig. 16). In sections a coarsely radiating structure is seen and also frequently a fine and regular concentric structure. As to the analyses of the stalactitic mineral the reader is referred to Nos. 6 and 7. In former times the mineral was generally classed with thomsenolite, but I am of the opinion that there are several reasons in favour of regarding it as p. The individuals are often positive in the longitudinal direction, in convergent light a rather large axial angle is seen; further nothing is visible of the basic cleavage of the thomsenolite, nor is, on the other hand, anything seen of the constant twin formations of p., but in an aggregate of this kind, where the individuals are intergrown with a strongly undulating extinction, it would hardly be expected to distinguish such a formation.

The mineral has later on been found in the cryolite occurrence in Colorado.

43. Thomsenolite. $AlF_3,NaCaF_3,H_2O$.

The Frederikshaab district.

Ivigtut.

J. Thomsen: Tidss. f. Physik og Chemie, 1862, p. 328.

Knop: Ann. d. Chem. u. Pharm. 127, 1863, p. 61. Bull. Soc. Chim. Paris, 1864, p. 138. Amer. Journ. Sci. 1866, p. 119.

Hagemann: Amer. Journ. Sci. 1866, p. 93. N. Jahrb. f. Min. 1866, p. 833.

Dana: System of Mineralogy, 1868, p. 129.

Nordenskiöld: Geol. Fören. Förh. Stockholm, 2, 1874, p. 84.

Wöhler: Nachr. Ges. Wiss. Göttingen, 1875, Nr. 23. N. Jahrb. f. Min. 1876, p. 58.

Knop: ibid. p. 849.

König: ibid. p. 662. Proc. Acad. Nat. Sci. Philad. 1876, p. 42.

Krenner: N. Jahrb. f. Min. 1877, p. 504.

Klein: ibid. p. 808.

Descloizeaux: Bull. Soc. Min. de France, 5, 1882, p. 310.

Brandl: Sitzb. d. Math. Phys. Classe d. Akad. d. Wiss. München, 1882, p. 118. Ann. d. Chemie, 213, 1882, p. 286.

Groth: Zts. Kryst. 7, 1883, p. 465.

Krenner: Math. u. naturw. Ber. aus Ungarn, 1, 1883, p. 162.

Bøggild: M. o. G. 50, 1912, p. 116. Zts. Kryst. 51, 1913, p. 601.

Bøggild: M. o. G. 50, 1912, p. 180. Zts. Kryst. 51, 1913, p. 617.
Gordon: Acad. Nat. Sci. Philad. Notulae Naturae Nr. 11, 1939.

With a monoclinic crystallization the crystals are most frequently bounded by *m* (110) and *c* (001) constituting three planes nearly at right angles to each other, which may now and then form a cubic figure, but most frequently forms long prisms. In opposition to pachnolite the prismal angle is nearly 90° (89°46′); besides the faces mentioned also *s* (331), *q* (111), (fig. 17) occur. More rarely various other faces.

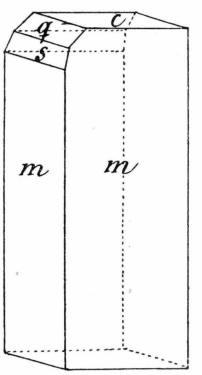


Fig. 17. Thomsenolite. (After Krenner).

Very strong cleavage parallel with (001) which face has a strong pearly lustre. Very faint cleavage in the direction of (110); the hardness is 3 (in most manuals it is given as 2, which is surely not correct). The specific gravity 2.93—3.0.

Optically negative: the axial plane is normal to (010); with the *c*-axis the acute bisectrix forms an angle of 52°22′ behind. The axial angle (2 V) is in yellow light 69°36′. Refractive indices: $\alpha = 1.407$, $\beta = 1.414$, $\gamma = 1.415$. Analyses by Hagemann (1), Wöhler (2), König (3), Nordenskiöld (4) and Brandl (5—7).

	1	2	3	4	5	6	7
F	50,08	[49,78]	[50.37]	[52.25]	50.65	50.62	50.61
Al	14.27	13.43	13.74	14.22	13.04	13.00	13.26
Ca	14.51	17.84	16.79	15.38	17.22	17.21	17.22
Na	7.15	10.75	10.10	8.87	10.02	10.49	10.43
H_2O . . .	9.70	8.20	9.00	8.92	8.48	8.33	8.42
Div. SiO_2	2.00		—	Mg 0.36	Mg 0.39	Mg 0.20	—
	97.71	100.00	100.00	100.00	99.80	99.85	99.94

The composition is exactly like that of the pachnolite, and in cases where crystals have not been developed, as e. g. in the stalactitic forms, the two minerals can hardly be distinguished with full certainty. The heating conditions are exactly alike.

T. like pachnolite occurs in three different manners.

1. As free crystals; the latter are, as described in the case of the pachnolite, to be found in cavities in transformed cryolite, which has probably brought about the very common characteristic form, viz. the cavities being bounded by three planes at right angles to each other. For the crystals of t. this leads to their being frequently found in a parallel position, which is never the case with pachnolite, and the parallel position not only applies to base, the face on which they are placed, but also frequently to the prismal faces. It is possible that there is here a kind of crystal skeleton formation, and that the apparently single crystals are in reality connected with each other. The crystals vary in form from cubic to elongated prismatic. T. frequently occurs together with pachnolite and also frequently with ralstonite, but it is found in far greater quantities than the two other minerals. T. can also be found as a very thin, brown coating on cryolite crystals, and in this case the crystals, strangely enough, do not seem to have a parallel orientation. The greater part of t. has more or less faint yellowish or brownish colour shades, and entirely colourless are, it seems, only some few but splendidly developed crystals, which are to be found in cavities in the stalactitic t. The crystals are considerably greater than pachnolite; as a rule the length and the width is 0.5—2 cm, but it may become as great as 5 cm.

2. T. in orientated intergrowht with pachnolite has been described under this mineral.

3. The stalactitic or agate-like formations in which t. always occurs together with fluorite. On the cryolite or on the minerals associated with it there is first a layer of granular t., on which the agate-like layers are found; they consist for the greater part of fluorite, but the latter is most frequently interrupted by thin layers of t. On top of the agate-like formations there is then again granular t., in which there are sometimes cavities with small, but very beautiful crystals of t. The agate-like layers have a fine and regularly concentric and sometimes also a radiating structure, but the latter is only visible in non-polarized light; with crossed nicols t. shows a quite irregularly granular structure. That it is really t., which we are dealing with, is beyond all manner of doubt. As to these formations the reader is, however, referred to the second of the author's above-mentioned treatises.

It was the Danish chemist, JULIUS THOMSEN, the founder of the cryolite industry, who first found and recognized t. as a proper mineral. KNOP and HAGEMANN considered it as a variety of pachnolite, and DANA gave it the name it now bears in honour of its discoverer. Outside Greenland the mineral has been found in quite small quantities, together with the Ural cryolite and the cryolithionite and furthermore in Colorado.

(Hagemannite).

The Frederikshaab district.

Ivigtut.

SHEPARD: Amer. Journ. Sci. 42, 1866, p. 246. N. Jahrb. f. Min. 1867, p. 193.
DANA: System of Mineralogy, 1868, p. 130.
GROTH: Zts. f. Kryst. 7, 1883, p. 480.
FRONDEL: The Amer. Mineralogist 33, 1948, p. 86.

H. is a brown, jasper-like substance which is perhaps not a single mineral but a mixture of different minerals; it is found as larger or smaller masses in the cryolite and, as it seems, nearly always connected with thomsenolite or pachnolite. The degree of coherence is very varying, and there are all possible transitions from a soft earthy mass to a hard and compact substance. By ignition h. sometimes decrepitates without melting, whereas in other instances it melts to a black, magnetic mass. Under the microscope we see an almost opaque, isotropic substance which may be intermixed with small grains of quartz or one of the fluorides, probably thomsenolite or pachnolite. An analysis undertaken by HAGEMANN, gave: F 40.30, Al 12.06, Na 8.45, Ca 11.18, Mg 2.30, Fe 5.96, Si 7.79, H_2O 10.44, insol. 1.08 = 99.56. This analysis cannot be correct, as the oxygen connected with Fe and Si and amounting to c. 11% has not been computed, but it may perhaps be imagined that Fe and Si have been written by mistake instead of the corresponding oxides. If the two substances are deducted as impurities, and the remainder is computed at 100, the result will be: F 49.25, Al 14,73, Na 10.32, Ca 13.66, Mg 2.79, H_2O 9.25, which composition is not so very far from that of thomsenolite or pachnolite. It must then be considered as probable that h. is an impure form of one of these two minerals. FRONDEL has found that h. is a variable mixture of ralstonite, thomsenolite and göthite.

(1st and 2nd regular minerals).

The Frederikshaab district.

Ivigtut.

BØGGILD: M. o. G. 50, 1912, p. 122. Zts. f. Kryst, 51, 1913, p. 607.
BØGVAD: M. o. G. 119, No. 7, 1939.

Both minerals crystallize in cubes, sometimes also with small octahedral faces; the size up to 1 and 2 mm, respectively. In occurrence and optical conditions they are different. Owing to lack of material they have not been analyzed.

1. The crystals are found among thomsenolite crystals; the faces are not particularly well developed; the specific gravity is 2.676, the refraction 1.3852. In the interior a pronounced sector structure, being as well positive as negative. The cubic faces are bases of the pyramids. The mineral is almost infusible, and the existence both of Na, Al and Mg has been proved in it. This naturally makes one look upon it as a ralstonite, and neither refraction nor specific gravity are against it; only, the pronounced cubic form and structure do not agree well with the ralstonite, which is pronouncedly octahedral.

2. Found in a greenish mass of mica containing intermixtures of quartz, fluorite, black cryolite, siderite and zircon. The faces are imperfectly developed, and some of the crystals are greatly disintegrated. The specific gravity is 2.377, the refraction 1.4420. In the interior sector-structure with the octahedral faces as bases the sign is always negative. The mineral is particularly fusible; the presence of Al, Ca and Na has been proved in it.

44. Atacamite. $CuCl_2 \cdot 3Cu(OH)_2$.

Exact locality not recorded.

PRIYADARANYAN RÂY: Centrbl. Min. etc. 1929, A, p. 318.

On an expedition undertaken by Dr. REISINGER and Dr. STEINBÖCK fragments were collected, which are reported to have been taken from rocks at the tidal boundary. No occurrence is mentioned, but it is known that this expedition has been in Godthaab and various other West Greenland localities. The rock is garnet amphibolite, coated with a thin white layer, superimposed by a green one, and it is in the latter that the existence of a. has been proved by means of micro-analytic methods.

IV. OXIDES AND HYDROXIDES

45. Cuprite. Cu_2O.

East Greenland.

Fleming Fjord (O. Nordenskjöld 1900).

O. Nordenskjöld: M. o. G. 28, 1909, p. 177.

The cuprite is reported to have been found in loose blocks of a siliceous limestone; the samples brought home, however, consist of quartzite, sometimes slightly calcareous. Besides thin veins of chalcocite the latter may also contain small areas of cuprite, the diameter being at most up to about 5 mm; both minerals are accompanied by malachite.

Wegeners Halvø (Noe-Nygaard 1931). Found as small masses (a few mm) in a boulder of limestone; the same areas which contain c., also contain small masses of malachite. The place is on the label stated to be Vimmelskaftet, and as this place is situated near the coast of Fleming Fjord, it is possible that this occurrence is identical with the one found by Nordenskjöld, but it is impossible to judge from his description where his locality is situated.

46. Bunsenite. NiO.

The Thule district.

Port Foulke. Reported by Emerson as being found together with millerite (see this mineral).

47. Spinel. $MgAl_2O_4$.

The Thule district.

Port Foulke.

Emerson: Amer. Geologist, 35, 1905, p. 94.

Here mention is made of rather large grains of a spinel, the colour of which is deep-blue, frequently black except at the edges. The grains are scattered irregularly in quartz in a quartz-biotite rock, they are surrounded by a strip of reddish brown biotite.

Uivfaq. The Godhavn district.

Nauckhoff: Bihang Vet.-Akad. Handl. Stockholm, Bd. 1, Nr. 6, 1872.

Laur. Smith: Bull. Soc. Min. de France, 6, 1878. — N. Jahrb. Min., 1879, p. 625. — Ann. de. Chim. et Phys., 1879, 5. serie, t. 16.

Törnebohm: Bihang Vet.-Akad. Handl. Stockholm, Bd. 5, Nr. 10, 1878.

Lorenzen: M. o. G. 4, 1883, p. 165.

Nicolau: M. o. G. 24, 1901, p. 235.

Found as small red grains in the graphite-bearing anorthite, which accompanies the native iron in this locality, and in smaller quantities also at the other iron occurrences on Disko and in the neighbourhood of the island.

The first to mention these grains is Nauckhoff who, however, does not investigate them in detail. Laur. Smith is the first to subject them to analysis (see below); the result of this is that he supposes them to be corundum, without attaching any importance to the circumstance that the optical properties do not agree with this mineral. Lorenzen explains the result of Smith's analysis by the methods used for the isolation of the mineral, which were such that the spinel became decomposed; he himself analyses the material, but without completing the analysis in the case of iron; however, it had been sufficiently proved that the mineral was spinel, which is also confirmed by Nicolau's complete analysis. The following analyses are undertaken by Laur. Smith (1), Lorenzen (2) and Nicolau (3).

	1.	2.	3.
SiO_2	0.95	0.20	0.46
Al_2O_3	92.02		74.95
Fe_2O_3	3.25	80.60	3.03
FeO			4.43
Cr_2O_3	—	1.24	0.91
MgO	2.68	19.11	17.83
	98.90	101.15	101.61

In all the analyses the quantity of the trivalent metallic oxides is too large, the quantity of magnesia too small (theor. $Al_2O_3 = 71.8$ and $MgO = 28.2$); the material is possibly somewhat decomposed by the isolating process; the analyses possibly also include some corundum, as this mineral, according to Moissan's investigations, is as a matter of fact contained in the rock at Uivfaq.

The Egedesminde district.

Agto (Mrs. Lassen 1874).

Kornerup: M. o. G. 2, 1881, p. 155.

A single crystal (about 2 cm) skeletally developed together with calcite and chondrodite. The form octahedral with strongly rounded edges, the colour greyish blue. As none of the numerous expeditions to this district have ever found these minerals in this locality, there is a possibility that the sample originates from the following locality.

Eqalugssuit (Kornerup 1879).

Kornerup: M. o. G. 2, 1881, p. 155.

Crystallized in the older collections in small crystals (1—4 mm), in dolomite together with chondrodite, olivine and phlogopite; in more recent times Fæster has handed in a sample with essentially greater (up to 2 cm) crystals. Form (111) with greatly rounded edges, sometimes traces of (110) and several forms. The larger crystals black, the smaller ones greyish blue. Specific gravity 3.55.

Nagssugtôk, northern side, about 22 km from the mouth (Pjetursson 1897).

Pjetursson: M. o. G. 14, 1898, p. 291.

In dolomite together with yellow olivine crystals and small shells of graphite and mica.

Without any definite locality (Rink).

Rink: Gr. I, 2, p. 206.

Kornerup: M. o. G. 2, 1881, p. 155.

Fragment of a larger crystal (2 cm) unconnected with other minerals and collected by the Greenlanders when hunting reindeer. Form (111) with narrow faces of (110) and traces of (331); the edges greatly rounded, the faces rather shining with deep grooves. The colour black, in small splinters vividly green. This crystal, which must thus be regarded as belonging to the pleonasts, presumably originates from layers of dolomite in the interior of the country.

Without any definite locality (Pfaff 1863).

1. Irregularly shaped grains (up to 1 cm) with calcite, muscovite and graphite. The colour very pure light-blue.

2. Grains (up to 1 cm) together with muscovite and oligoclase; most frequently without crystal form; in a cavity octahedrons were found with faces of (311). The colour rather pure and blue.

It is possible that these samples originate from the layers of dolomite mentioned above, but as they do not agree entirely with the spinel from any of those, they may naturally have a different origin.

The Holsteinsborg district.

Ungôriarfik (Kornerup 1879).

Kornerup: M. o. G. 2, 1881, p. 155.

Crystallized (up to 7 mm) in dolomite together with olivine, phlo-

gopite and graphite. The form is an incompletely developed octahedron, though frequently with extremely shining faces. The colour dark bluish grey. Specific gravity 3.55.

Without any definite locality.

KORNERUP: M. o. G. 2, 1881, p. 156.

A few pleonast crystals of exactly the same type as the one brought home by RINK from the Egedesminde district; reported to originate from the interior of the district.

The Godthaab district.

Auvaitsersarfik (GIESECKE 1-6-1810). Found as numerous grains in the sapphirine-bearing rock; the size of the grains is up to a few mm, the form is irregularly rounded. The colour is black and the mineral is mostly quite opaque; only in the thinnest splinters it proves to be a little translucent with an indistinct greyish or brownish colour. Rather strongly magnetic. As the mineral is perfectly isotropic it must be a spinel rich in iron, perhaps picotite or magnesioferrite.

Fiskenæsset.

LORENZEN: M. o. G. 7, 1893, p. 19.

USSING: Zts. Kryst. 15, 1889, p. 597.

Occurs in the sapphirine-bearing rock (2nd type, USSING) together with bronzite, sapphirine and a smaller quantity of light-brown mica. S. occurs partly as irregular grains, sometimes with traces of octahedral faces, partly as greater masses. The colour is black with a faint greenish tinge, in thin splinters dark green. Analysis undertaken by LORENZEN: SiO_2 0.23, Al_2O_3 70.05, FeO 9.86, MgO 21.25 = 101.39.

East Greenland.

Southern part of the east coast.

EBERLIN: M. o. G. 9, 1889, p. 255.

Here it is said that the information contained in Peterm. Mitt., 1885, p. 58 according to which EBERLIN should have found bornite, euxenite and spinel is due to a premature report, which was written before the minerals collected in the summer of 1884 had been packed out and examined.

Grusgraven (ɔ: the gravel pit) (KRUUSE 1899).

O. NORDENSKJÖLD: M. o. G. 28, 1909, p. 7.

Irregular grains of a dark-green colour in hornblende rock.

Liverpool Land, at the innermost end of Hurry Fjord (O. NORDENSKJÖLD 1900).

O. NORDENSKJÖLD: M. o. G. 28, 1909, p. 283.

Grains of s. are mentioned together with chondrodite and various other minerals in granular limestone.

Greenland without a definite locality.

From early times we possess a fairly large quantity of rather small (2—5 mm) incompletely developed crystals; they are essentially different from the known Greenland occurrences in that they are very nearly black in reflected light, but colourless or greyish in transmitted light, whereas s. is otherwise very vividly coloured. The rather large number (about 200) makes it more or less probable that the crystals have really been collected in Greenland and not, as must so often be supposed to be the case with isolated samples, originating from Greenland and brought there by former travellers or employees.

48. Chromite. $FeCr_2O_4$.

The Thule district.

The region round Kap York.

BØGGILD: M. o. G. 74, 1930, p. 21.

Found in small quantities in some of the troilite concretions in the Savik meteor. The form is irregular and the size from 1 to a few mm.

The Umanak district.

Niaqornat (SOLE MUNCH 1939). Numerous small, nearly microscopic grains in green mica (see this mineral).

The Holsteinsborg district.

Sarqaq's Kangerdluarssuk, 0.6 km northeast of the end of it.

BALL: M. o. G. 63, 1932, p. 37.

From this locality c. is mentioned as a constituent of dunite in two different forms, partly as grains or crystals scattered in the rock, partly as aggregates in association with white mica, probably muscovite.

The Sukkertoppen district.

Siorârssuit at Kangâmiut (J. A. D. JENSEN 1884).

RØRDAM: M. o. G. 8, 1889, p. 27.

Very small grains (about $^1/_2$ mm) in a partly serpentinized olivine-rock, curiously enough also in the entirely fresh parts of the latter. The shape of the grains irregular; crystal faces rarely occur.

Tasiussarssuaq[1]).

BALL: M. o. G. 63, 1932, p. 37.

[1]) BALL places that locality in "the general vicinity of Sukkertoppen"; in that part of Greenland we only know two localities with the name Tasiussarssuaq, the one lying in the Egedesminde district the other in the southern part of the Godthaab district.

From the mouth of this fjord mention is made of small lenses of fine-grained or coarsely crystalline c. In certain lenses the olivines are intergrown with c., but also in such cases there is a sharp boundary between the dunite and the aggregates of c.

The Julianehaab district.

Kitsigsut Øer (Giesecke).
GIESECKE: Catalogue of minerals, p. 207.
Recorded to occur in syenite together with zircon.

49. Magnetite. Fe_3O_4.

Found in a great number of occurrences, but mostly not in very large quantities. In the following only more considerable and characteristic occurrences are mentioned.

The Upernavik district.

Grisebugt (GIESECKE 17-7-1807). In pegmatite together with oligoclase and smaller quantities of biotite and quartz, in the shape of larger individuals (up to 1 dm), partly enclosing poorly developed oligoclase crystals. The surface oxidized with bluish colours.

The Ritenbenk district.

Ritenbenk (SYLOW 1883).

SYLOW: M. o. G. 8, 1889, p. 25.

Here it is recorded that there is a huge block of m. on Ritenbenk-Ø. A sample shows it to be greatly intermixed with other constituents, and in sections there are more particularly areas of a common quartz sandstone. The specific gravity is determined at 3.96, which points towards half of it being m.

Igdlukúnguaq (STEENSTRUP 1872). Found in small quantities in pyrrhotite, most frequently together with siderite. Size about 1 mm. Octahedrons with well-developed shining faces.

The Godhavn district.

Uivfaq (NORDENSKIÖLD 1870).

NORDENSKIÖLD: Öfvers. k. Vet.-Akad. Förh. Stockholm, 1870, p. 973. — Geological Magazine, 9, 1872, p. 289.

Occurs in the iron-bearing basalt, in the detritus of which Magnetite octahedra with very shining faces were collected.

The Christianshaab district.

Suilaussaq at C. (Rink).

Rink: Ngr. p. 44.

Crystallized in pegmatite, in the shape of very large (up to 2 dm) octahedral crystals which are, however, strongly skeletally developed, interrupted by quartz and felspar. Strong parting parallel to the octahedral faces.

Nûk (Sylow 1883).

Sylow: M. o. G. 8, 1889, p. 27.

Found in irregularly formed masses together with tremolite, graphite and garnets; sometimes m. forms minor layers in the gneiss, up to 16 cm in thickness.

The Egedesminde district.

Vester Ejland, Kangâtsiaq and Portusut (Pjetursson 1897).

Pjetursson: M. o. G. 14, 1889, p. 298.

Irregularly formed masses (up to 7 cm) in pegmatite, each consisting of a single individual with an octahedral parting; in cavities a few crystals were found.

Inugsulik (Giesecke). Fragment of an isolated octahedral crystal (size 5 cm); the faces only partly developed and dull.

The Holsteinsborg district.

Nâlagánguaq (Kornerup 1879). Occurs as phenocrysts (2—15 mm) in a fine-grained black, peridotitic rock. The grains occur in very large quantities, making as far as can be seen about a third of the whole rock, and in addition to the larger grains there are also numerous, quite microscopical grains in the ground-mass. The grains have no distinct crystal shape.

The Godthaab district.

Simiutaq (Rink), Rather large quantities in granular actinolite; the isolated individuals may attain several cm in diameter. In several cases a distinct parting.

The Frederikshaab district.

Arsuk Storö (Giesecke 18-6-1806). Reported to have been found, together with hematite and massive epidote, in great quantities on the island; from this Giesecke concluded that there must be a large iron bed in the interior of the island; this conclusion was supported by the quantity of iron vitriol, coating the river beds, and by the loose blocks of siderite and limonite, scattered on the island.

Grønnedal (Holst 1880, Bøgvad 1938—39).

Holst: Sveriges geol. Unders. Ser. C, Nr. 81, 1886.

Callisen: M. o. G. 131, Nr. 8, 1943, p. 21.

Bøgvad: Medd. D. geol. Foren. 11, 1947, p. 241.

Holst describes the occurrence as a layer in limestone situated between Grønnedal and Íka Fjord, and he writes about it that the ore is so rich that in another place it would have been worth mining. Bøgvad rediscovered the occurrence and writes about it (in Callisen) that the iron ore deposit occurs at the south side of Grønnedal. The streambeds in that place are rust-coloured over long stretches, and frequently blocks of magnetite are found lying about. The occurrence seems to be extended in shape and is chiefly situated within the nepheline syenite area. The size of a strongly ferriferous part of the occurrence, abt. 320 m above sea level, was estimated at $300 \times 100 \times 50$ m, but the borders were not determined. Later magnetic measurements by Bøgvad (in 1947) have shown, that there are two areas, in total amounting to 80000 m². An analysis by H. A. Nielsen gave the following result: SiO_2 1.19, TiO_2 0.89, Fe_2O_3 68.96, FeO 26.03, MnO 0.02.

Ivigtut. As regards m. from this locality see what is written about hematite (p. 109). It seems most probable that pseudomorphoses occur in which the hematite has become more or less altered.

The Julianehaab district.

North Kitsigsut islands (Giesecke 7-8-1809). It is reported that the cliffs on these islands consist of syenite, in which there are very thick beds of m. together with hornblende and zircon. Here is also found very pure magnetite sand.

Nunarssuit (Giesecke 1-7-1806). Mention is made of large samples scattered everywhere, from which it may be concluded that there are large iron-beds on the island. Among the samples brought home there are a few with small crystals in a syenite containing arfvedsonite. Form cubical and octahedral with rather imperfectly developed faces.

Qôroq (Qôrorssuaq) and Niaqornârssuk (Giesecke 2-9-1806). From here great layers of m. are reported; the rock is said to be large-grained granite, but there is hardly any doubt that it is the nepheline- or augite-syenite occurring in that locality. A number of samples have been found which differ from the others by having a quantity of crystals (size: about 5 mm) on the walls of fissures; they are almost exclusively bounded by (110) with regularly developed, but dull faces.

Narssârssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 226, 230.

Flink: M. o. G. 24, 1901, p. 23.

Only found in small quantities in the syenite-pegmatite; the size

up to 3 cm. M. is somewhat titaniferous; crystal faces are rare, mostly octahedral with deep striae parallel to the edges between them, the latter being caused by the occurrence of narrow dodecahedral faces. The faces upon the whole rather shining.

Iganeq (STEENSTRUP). A couple of loose fragments, the one of an octahedral crystal (up to 5 cm in diameter). The crystal very incompletely developed with uneven and dull faces.

50. Corundum. Al_2O_3.

C. is reported as being found in various localities, but only a couple of occurrences can be regarded as reliable.

The Godhavn district.

Uivfaq.

LAW. SMITH: Ann. de Chim. et Phys. 16, 1879, p. 34.

MOISSAN: Compt. Rend. 116, 1893, p. 1269.

Some red grains which are found in the plagioclase concretions abounding in graphite, were interpreted by LAW. SMITH as c., but other investigators have proved them to be spinel. By chemical methods MOISSAN has isolated small, microscopical grains consisting of sapphire.

The Godthaab district.

Auvaitsersarfik (GIESECKE 1-6-1810). Found as irregularly formed grains in a mixture of gedrite, sapphirine, spinel and mica. The individuals may, to be sure, attain a dimension of several cm, but in the sections they are only seen as small areas which, because of their uniform extinction, show that they are connected with each other through many neighbouring cavities. There is a strong parting along the faces of the rhombohedron; the colour is faintly reddish.

Fiskenæsset (GIESECKE).

GIESECKE: (The Miner. Geology of Greenland 1816. "Rejse", 1878, p. 341.

The "emery" from Qeqertarssuatsiaq mentioned here, has been proved to be sapphirine.

The Frederikshaab district.

Smallesund (STEENSTRUP). In a gneiss found in this locality there are, besides large flakes of biotite, small (a few mm) grains of a rather vivid blue c.; it shows the usual parting parallel to the rhombohedral faces.

Arsuk Storö (GIESECKE 18-6-1806). From here scattered samples of emery are mentioned; the determination can hardly be regarded as reliable.

The region round Qipisarqo (GIESECKE).

GIESECKE: Catalogue, p. 207.

Here c. is mentioned in granite.

East Greenland.

Kap Ivar Huitfeldt (LAUBE 1870).

LAUBE: Die 2te Deutsche Nordpolarfahrt, 1869—70, 1, p. 123. — Wien. Akad. Sitzungsber. 68, 1873, p. 76.

EBERLIN: M. o. G. 9, 1889, p. 76.

As an accessory in granite violet-blue c. is reported to have been found together with a hyacinth-red garnet. EBERLIN is of the opinion that this c. is in reality iolite, as he himself mistook these minerals for each other in the regions in question and mentioned the occurrence of sapphire in his reports, from which the information has crept into Petermanns Mitt. 1885, p. 58.

Greenland without any definite locality.

ROBERT: Bull. Soc. Géol. de France, 12, 1841, p. 369.

From Senator BINGER in Hamburg ROBERT received a sample of blue sapphire, contained in a rock consisting of felspar and calcite with ilmenite; the sample is reported to originate from Greenland.

In 1911 NYROP LARSEN presented the Mineralogical Museum with a corundum crystal, together with other minerals from Greenland. It is rather large (2—3 cm in diameter) and unconnected with other minerals, except a few flakes of mica. The form is prism and base, and there are distinct traces of parting parallel to the rhombohedron; the faces are uneven and dull, the colour reddish. It must be regarded as rather doubtful that the crystal originates from Greenland.

51. Hematite. Fe_2O_3.

H. has, it is true, been observed in a number of localities in Greenland, but everywhere only in rather small quantities. Here the following will be mentioned:

The Thule district.

Dallas Bay (L. KOCH). Crystals (up to 2 cm) in granite; rather incompletely developed, as a rule with a bright and shining base, and a few rhombohedral faces ($10\bar{1}1$), imperfectly developed and dull. Strong parting parallel to the base. According to the label the samples are reported to have been found in D. B.; but as there are only sedimentary formations in this locality, it seems that they must originate from a boulder.

Kap York.

BELKNAP: Amer. Mineralogist, 19, 1934, p. 433.

In the moraine a number of small boulders of hematite or hematitic quartzite were found, from which BELKNAP concludes that there must be iron ore *in situ* in a northern direction, for instance, at De Dødes Fjord (Dead Men's Fjord), which would also explain the striking abnormality of the magnetic declination at Cape York.

The Ritenbenk district.

Paotût (STEENSTRUP 1873). Among pebbles on the shore a sample was found, weighing 1 kg and consisting of h. with a little burnt shale

on one side. H. is fine-grained, apparently quite pure; as it is rather strongly magnetic, it must, however, contain a certain quantity of magnetite.

The Frederikshaab district.

Arsuk Storö (Giesecke 18-6-1806). Mentioned together with magnetite in massive epidote. From various phenomena Giesecke concludes that there must be a "ungeheures Eisenlager" in the centre of the island.

Island in Arsuk Fjord (Hamburger, mate, 1856). Crystallized together with muscovite with curved faces in cavities in sandstone. The size of the crystals up to 4 cm; as a rule they are rather imperfectly developed. Combination (0001), $(10\bar{1}1)$, $(11\bar{2}0)$, $(22\bar{4}3)$; the faces dull; strong parting parallel to $(10\bar{1}1)$.

Another sample from the same locality was handed in by the manager of the settlement. The occurrence greatly resembles the preceding one, in so far as there are also here crystals together with mica with curved faces in sandstone, but the form is quite different, viz. thin tables with strongly shining faces of (0001), no other faces being developed. It must, it seems, be regarded as probable that both of the finds originate from the same island.

Ivigtut (Ussing 1900). Obtained in fairly large quantities, more particularly in the mass of pegmatite found between the granite and the southern side of the cryolite. H. occurs together with most of the minerals characteristic of Ivigtut, viz. quartz, siderite, felspar and cryolite. The mineral forms flat, but quite irregularly shaped masses with an extent of several cm; in a few cavities crystals may be found, bounded by (0001) and $(10\bar{1}1)$. A peculiarity of the Ivigtut h. is that it is always intermixed with magnetite in a very different proportion. H. is the most visible of the minerals because of the large shining faces of the base, whereas the magnetite is naturally recognizable by the greater or smaller magnetism. In a finely pulverized state numerous small, vividly red flakes are visible.

The Julianehaab district.

Kingokotala qingua (Steenstrup 1877). Very small scales (only about 0.5 mm) found on and within rock crystals from the red sandstone.

Sagdliaruseq (Steenstrup 1899) nearly like the preceding; also as small, black spots in the rock-crystals and as an impregnation in the latter.

A Greenlander at Igaliko handed in samples, which resemble those from the localities mentioned, in so far as they consist of rock-crystals, reddish in colour because of a thin layer of very fine-grained

hematite on the outside of the crystal faces. But here very large calcite individuals are found in the rock-crystals, and among the latter and still more in fissures in the calcite there are groups of hematite crystals, which may be nearly spherical, up to 1 cm in diameter and, if broken across, showing structures like the so-called "Eisenrosen".

South Siorârssuit (LYTZEN's collection 1889).

FLINK: M. o. G. 14, 1898, p. 243.

BØGGILD: M. o. G. 25, 1902, pp. 49 and 71.

Found together with ilvaite, garnet, albite and other minerals in the altered sodalite-syenite, as a rule in the shape of small (1—2 mm) scales, but sometimes also as somewhat larger rosettes (up to 3 cm); no distinct crystal forms were found.

The region of Kangerdluarssuk.

USSING: M. o. G. 14, 1898, p. 200.

The h. forms finer or coarser scales or flakes together with acmite in altered arfvedsonite.

Igaliko (STEENSTRUP).

STEENSTRUP: M. o. G. 2, 1881, p. 37.

An impure massive red hematite is found as a 5 cm thick layer between the sandstone layers at the portage. STEENSTRUP reports that the hematite, like the iron from Uivfaq, has the quality of keeping quite fresh in nature, but shows signs of crumbling when it has lain for a couple of years in the museum. There is, however, one specimen which has lain for thirty-six years in the museum and still looks quite fresh.

Qaersoq (GIESECKE 12-8-1806). Here mention is made of h. together with magnetite, as layers in granite. In samples kept in the Mineralogical Museum of Copenhagen no magnetite is seen, but the h. occurs together with albite and orthoclase, and it must here, as in other occurrences of h., be a case of transformation by the action of hot vapours. The form is generally quite thin, small tables, sometimes hexagonal in outline, but upon the whole without any distinct forms.

East Greenland.

Liverpool Land (ROSENKRANTZ 1927). At Gipselv (ɔ: gypsum river) in basalt contact in the Klitdal formation small crystals (1—2 mm) were found segregated on sandstone. The form not definable in details.

52. Ilmenite. $FeTiO_3$.

The Upernavik district.

Nutârmiut (RINK). Found as small grains (1—5 mm) in pegmatite; the shape irregular.

The Umanak district.

Storöen (Rink).

Rink: Ngr. p. 40.

Rink: Gr. I, 2, p. 245.

Found as irregularly formed masses (up to 15 cm) together with garnet in hornblende schist. Also as small (1—2 cm) tabular crystals in pegmatite, consisting of oligoclase, quartz and hornblende; it is these crystals which Rink terms an unknown mineral resembling yttrotantal. The crystals are imperfectly developed with indefinable marginal faces.

The Christianshaab district.

Sarpiussaq (Sylow 1883). Crystallized in pegmatite, together with quartz, felspar, actinolite and apatite. The crystals tabular (1—5 cm), very irregularly developed without definable marginal faces.

Ikamiut and Puagiarssuk (Rink). Irregular masses (up to 8 cm) in large-grained gneiss together with oligoclase, quartz, tourmaline and chlorite.

The Holsteinsborg district.

The foot of Kællingehætten (Fæster 1929). A number of small grains found at the boundary of a pegmatite vein, consisting of felspar and some quartz and hypersthene. The shape of the grains quite irregular.

The Sukkertoppen district.

Kangerdlugssuaq (Lütken 1875). A few loose-lying fragments, unconnected with other minerals, excepting thin layers of malachite. A few of the samples are magnetite, others ilmenite, among others the largest of them (3 cm); the form irregular.

The Julianehaab district.

Narssârssuk? This occurrence of ilmenite, which is surely the finest in Greenland, is unfortunately not known in details. All that is known is that the samples were collected by Greenlanders and handed in together with minerals from N.; it is thus at any rate probable that they originate from that region. The mineral is found in the shape of crystals in a pegmatite consisting of oligoclase and quartz, and it is also accompanied by a small quantity of pyrite. The shape is tabular, parallel to the base; the thickness up to 1 cm, the extent up to 4 cm. The crystals are bounded by $(10\bar{1}1)$ and $(02\bar{2}1)$. The faces are rather plane, but quite dull.

East Greenland.

Kap Daniel Rantzau, the country around (Eberlin 1884). In granite pegmatite together with titanite; irregular mass (up to 8 cm); strongly oxidized and disintegrated.

53. Perovskite. $CaTiO_3$.

The Frederikshaab district.

Frederikshaab Glacier (Holst 1880).

Törnebohm: Geol. Fören. Förh. Stockholm, 6, 1883, p. 705.

Found as an accesbory constituent together with magnetite and calcite in a melilite basalt consisting of melilite, olivine and mica. P. is found in the shape of small grains (about 0.1 mm) of a purple-brown colour, sometimes faintly birefringent.

(Pyrochlore). $(Ca,Na,Ce)(Nb,Ti.Ta)_2(O,OH,F)_7$.

This mineral is mentioned several times as being found in Greenland, but nowhere with certainty. Törnebohm (Geol. Fören. Förh. Stockholm 6, 1883, p. 695) mentions small octahedral crystals (about 0.1 mm) in augite-syenite; they are of a clear, brownish-yellow isotropic mineral possibly p. from Grønnedal, the Frederikshaab district. Flink (M. o. G. 14, 1898, p. 234) records p. from Narssârssuk in the Julianehaab district, which mineral by means of a later examination has proved to be chalcolamprite; in the same treatise (p. 255) he mentions small greyish-brown octahedrons, found at the foot of Igdlerfigssalik in the Julianehaab district; these might be p. but they have not been subjected to a more detailed investigation.

54. Microlite. $(Ca,Na)_2(Ta,Nb)_2(O,OH,F)_7$.

The Julianehaab district.

Narssârssuk (Lytzen's Collection 1893).

G. Nordenskiöld: Geol. Fören. Förh. Stockholm 16, 1894, p. 336.

Flink: M. o. G. 14, 1898, p. 234.

Flink: M. o. G. 24, 1901, p. 171.

Found as crystals in the pegmatite, most frequently half-sunk in ægirine crystals, together with a later generation of ægirine, polylithionite, albite, elpidite etc. The size of the crystals never attains 1 mm, most frequently they are microscopical. Nearly always octahedrons, frequently distorted into tetrahedron-like or elongated forms; sometimes there are also small cubic faces. At times the faces are well developed, and then again very much rounded and indistinct. The colour varies greatly; the largest and most developed crystals are brownish-yellow with a red tinge; the less developed greenish-yellow with a brownish tinge. In a single case very small crystals were found forming a crust and completely colourless.

An analysis has been undertaken by Nordenskiöld on a material consisting of 0.0303 gr., so that it cannot claim to be very accurate: $(Ta,Nb)_2O_5$ 54.8, SiO_2 13.5, SnO_2 3.0, $(Fe,Al,Ce,La,Di)_2O_3$ 12.2, CaO 9.6; loss 6.9 = 100.0. The rest probably consists of fluorine and alkalies, the silica in all probability originating from ægirine; if it

is deduced together with a corresponding amount of metals, the result is (Nb, Ta)$_2$O$_5$ 74.0, SnO$_2$ 4.0, CaO 12.1 (Ce, La, Di)$_2$O$_3$ 4.2, loss 5.7 = 100.0. This agrees fairly well with the composition of the m. from other occurrences.

55. Chalcolamprite. $RNb_2O_5F_2 + RSiO_3 (R = Zr, Ce, \overset{III}{Fe}, Ca, Na)$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 234.

FLINK: M. o. G. 24, 1901, p. 160.

The form of the crystal exclusively octahedral, up to 5 mm; the faces shining, but not particularly plane. The crystals often look as if they had been broken and then again cemented together; sometimes they are skeletally developed, sometimes hollow. No distinct cleavage. The fracture splintery or conchoidal. The hardness 5$^1/_2$, the specific gravity 3.77. The colour is dark greyish-brown with a reddish tinge, on the crystal faces with a peculiar metallic lustre, frequently of a copper-red colour (hence the name of the mineral which means copper-lustre). The streak is ash-grey; only transparent in thin splinters.

C. is infusible before the blow-pipe and is not decomposed by acids. Analysis undertaken by MAUZELIUS: Nb$_2$O$_5$ 59.65, SiO$_2$ 10.86, TiO$_2$ 0.52, ZrO$_2$ 5.71, Ce$_2$O$_3$ etc. 3.41, Fe$_2$O$_3$ 1.87, MnO 0.44, CaO 9.08, K$_2$O 0.38, Na$_2$O 3.99, H$_2$O 1.79, F$_2$ 5.06 = 102.76 ÷ 0 (= F$_2$) 2.13 = 100.63. It is hardly possible to deduce any reliable formula from these figures.

In his "Tabellen" STRUNZ records c. in association with pyrochlore and adds that the 10 % SiO$_2$ must surely in part be due to enclosed ægirine. To this must, however, be observed that the impression received from an examination of thin sections of c. is that the amount of ægirine must be very small and hardly ever reaches 1 %, which corresponds with about 0.5 % of SiO$_2$.

C. has been found in rather sparse quantities and only within a small locality; it mostly occurs together with ægirine and is frequently penetrated by needles of this mineral; besides, it is found together with zircon, albite, ancylite and other minerals.

56. Endeiolite. $RNb_2O_5(OH)_2 + RSiO_3 (R = Zr, Ce, \overset{III}{Fe}, Ca, Na)$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 24, 1901, p. 166.

Crystallizes exclusively in octahedrons (up to 2 mm); they are generally found fixed on one side and are then flattened. The faces are shining, but not quite plane. Sometimes the crystals are develope

as tetrahedrons which may, however, be due to chance. Twins are rather common. No cleavage; the fracture conchoidal or splintery. The hardness is a little more than 4, the specific gravity 3.44; the colour is dark-brown, the streak is yellowish-grey. The lustre on the crystal faces is a strong vitreous lustre, on fractures greasy.

Infusible before the blow-pipe and not to be decomposed by acids. The analysis has been undertaken by MAUZELIUS on 0.6176 gr: Nb_2O_5 59.93, SiO_2 (12.48), TiO_2 0.76, ZrO_2 3.78, Ce_2O_3 4.43, Fe_2O_3 2.81, MnO 0.37, CaO 7.89, K_2O 0.43, Na_2O 3.58, H_2O 4.14, F_2 0.69 = 100.29 ÷ O (= F_2) 0.29 = 100.00. Also in this case it is hardly possible to give any reliable formula.

E. has only been found within a single small occurrence consisting of pegmatite veins; the crystals are fixed to ægirine crystals, imbedded in a porous mass of elpidite; in rarer cases e. is to be found directly on the elpidite needles. Other accompanying minerals are leucosphenite, epididymite, polylithionite and other minerals.

The name is created by FLINK from a Greek word, meaning "want", on account of the large loss to be found in the analysis. FLINK calls attention to the great similarity between this mineral and chalcolamprite; however, the chalcolamprite has an essentially greater fluorine content than the endeiolite, in specific gravity and hardness the two minerals differ considerably and furthermore endeiolite often occurs in twins whereas twinning is unknown on chalcolamprite.

None of these two minerals have been found elsewhere.

57. Quartz. *SiO_2*.

Owing to the common occurrence of this mineral it has been necessary to leave out many localities, even such as have well-crystallized material, and only to deal with the most considerable or in other ways interesting occurrences.

The Upernavik district.

Prøven (OLRIK 1863). Crystals (up to 2.5 cm) on a crust of prehnite. The form the usual one; the one rhombohedron as a rule distinctly smaller than the other. Clear and colourless.

The Umanak district.

Sarqaq (F. JØRGENSEN 1887). Loose crystals, only developed at one end, without any rock. Very clear and transparent, the size 1—4 cm. Combination: (10$\bar{1}$0), (10$\bar{1}$1) and (01$\bar{1}$1), besides various steep pyramids; also (11$\bar{2}$1), (2$\bar{1}$11), (51$\bar{6}$1), (6$\bar{1}$51) in addition to several other trapezohedral faces. Sometimes twin formations according to the usual law.

Kangilia (Rosenkrantz 1946). Here was found a loose-lying sample forming part of a geode with the following succession of layers: (1) a layer of grey chalcedony with a microscopically rather irregular fibrous structure, (2) white chalcedony (c. $^1/_2$ mm) with a very regular structure, and (3) rock crystals forming a layer of c. 1.5 cm's thickness with crystals protruding into the cavity. The form is the usual one.

Niaqornat. In more recent years a number of rock crystals have been collected in somewhat different localities in the neighbourhood, being formed under conditions which differ very much from each other. Giesecke found (30-5-1811) semi-transparent crystals (up to 3 cm) on a light, fine-grained rock together with dolomite crystals. In 1924 Greenlanders collected a number of crystals and groups of crystals; on a single one of these there is some of the surrounding rock, which seems to be a greatly altered olivine basalt, where everything, with the exception of the labradorite, had been changed into carbonates.

In 1938 Rosenkrantz brought home a quantity of rock-crystals from the region round Niaqornat, the number of these samples being particularly large from a place called Narssarssúnguaq; further, there are smaller crystals with especially well-developed faces, clear and transparent, from a place called Scaphites Ravine (Kugssiníguaq), where they were found scattered in cavities in *Scaphites* enclosed in concretions; similarly from a locality called Hamites Ravine. A number of the crystals are freely developed on all sides. The combination is the usual one.

Of quite a different kind is a sample collected by Sole Munck in 1939, which is reported to originate from a vein in the peridotite. It consists of a columnar aggregate, the length of the columns being up to 7 cm, the width a few mm. The peculiar thing about it is that the columns partly consist of quartz and partly of calcite, forming very irregular boundaries. The quartz constitutes by far the greater part of the aggregate.

Avataussaligssuaq near Agatdalen (ɔ: the agate valley). (Rosenkrantz 1946). Here the Greenlanders have collected samples of quartz, mostly as irregularly bounded anhedrons (up to 7 cm long); only rarely we find faces of the common form. The substance is very pure, colourless and transparent.

The Ritenbenk district.

Qutdligssat (Porsild 1908). Here rock crystals of a very peculiar shape were found on the walls of cavities in chalcedony. The length of the crystals is up to 1 cm, the thickness up to 0.5 cm; they are clear and colourless, but as the faces are dull, they are not particularly transparent. There is only one of the two usual rhombohedrons, either $(10\bar{1}1)$

or $(01\bar{1}1)$, whereas every trace of the other one is lacking. Attached to the sides of the crystal are most frequently smaller crystals in twin orientation to the main crystal, so that the main axis is a twin axis. In this manner there may be as many as three smaller crystals on each main crystal, so as to create complexes as shown on fig. 18; the faces are not particularly well-developed, and the only plane faces are the upper parts of the rhombohedrons on some of the crystals; the rhombohedrons are horizontally striated and yield a long series of reflexes among which that of the main form is very pronounced, whereas it is

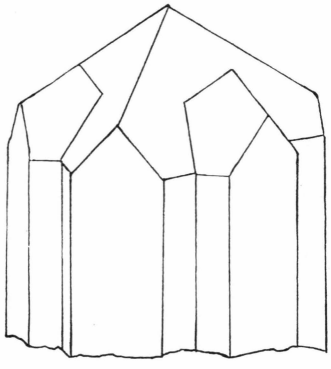


Fig. 18. Quartz, Qutdligssat.

hardly possible with certainty to identify other rhombohedrons. The prismatic faces as usual have horizontal striae; they only yield imperfect reflexes.

The Godhavn district.

Nordfjord (Jensen-Aaris 1933). In a locality in Stordalen called Ametystskrænten (ɔ: the amethyst slope) a fragment of chalcedony has been found with a layer of quartz, about 6 cm thick; at the outer edge it is white and columnar, but farther in it merges into clear crystals of a faint violet colour. The thickness of the crystals is about 1 cm, with the usual faces.

The Jacobshavn district.

Atilik (Steenstrup 1872). Crystals (up to 3 cm) on a fissure in gneiss; besides the three usual forms there are on most crystals $(11\bar{2}1)$, $(32\bar{5}3)$ and $(51\bar{6}1)$. Some of the crystals right- and others left-handed. Rather clear and transparent, the faces being frequently coated with a reddishbrown layer.

The Egedesminde district.

Tulugartalik. Fragments of a large prism (diameter 5 cm).

The Sukkertoppen district.

Sukkertoppen.

Schumacher: Naturh. Selsk. Skr. 4, 2. Hefte, 1798, pp. 221—225.

A very detailed description of a number of distorted and flattened crystals; only the usual combination is to be found. The size 4—8 cm; a single crystal smoke-brown.

The Frederikshaab district.

Kungnait (Giesecke 13-8-1809). Here mention is made of small cavities in granite, with rock crystals and amethysts. In 1907 J. Petersen, Controller, found a rather large crystal (11 cm long, 7 cm broad) at a height of 1000 m; it was black in colour, but it seems as if the blackness is limited to the outer layers, a few mm in thickness, whereas the inner part is greyish.

Ivigtut (Giesecke 10-8-1809).

Giesecke: Edinb. Phil. Journ. 6, 1921—22, p. 141. — Manual of Greenland, p. 344.

Tayler: Quart. Journ. Geol. Soc. London, 12, 1856, p. 146. — Manual of Greenland, p. 344.

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 240.

Found in very large quantities as crystals interspersed in the whole mass of cryolite, with the exception of its quite pure coarse-crystalline varieties, together with the various ores; of these only the siderite is to be found in larger quantities than the quartz. Further it is found in a quartz-felspar pegmatite, west of the cryolite, together with a number of different minerals. Here the quartz-crystals are mostly found as projecting freely. The form of the crystal is nearly the same everywhere; the prism faces are mostly well developed, the rhombohedral faces, on the other hand, rarer. The size varies greatly, from a couple of cm to about 1 m in length and 30 cm in witdh. The colour impurely whitish and greyish. The faces extremely uneven, with large projections and deep pits and grooves.

The Julianehaab district.

Ivínguit.

Steenstrup: M. o. G. 34, 1910, p. 140.

From here there is a description of some extremely unusual pseudomorphs which partly seem to occur as phenocrysts in an eruptive rock, even though they are, for the greater part, detached by its decomposition. The rock is a fine-grained mixture of albite and ægirine, but this has not necessarily been the original composition, as it may very

well have been altered by the process producing the pseudomorphs. The latter consist of quartz, which also contains a large amount of ægirine needles; the shape etc. has been described by Ussing (in Steenstrup) as rhombic (or possibly pseudo-rhombic) (001) prevailing, otherwise (111), rarely (010); the angles determined by contact goniometer are: (111):(11$\bar{1}$) = about 46°; (111):($\bar{1}$11) = about 91°, (111):(1$\bar{1}$1) = about 72°. It is impossible to imagine the nature of the original mineral. The size is, in most instances, about 2 cm.

Kingokotala qingua (Ipiutaq).

Hans Egede: Det gamle Grønlands nye Perlustration, Kbh. 1741, p. 26.

Leonhard: Hdb. einer topogr. Mineralogie, 1, 1805, p. 80.

Giesecke: 1-8-1809.

Steenstrup: Tillæg B til Rigsdagstidende for 1877, p. 7.

Steenstrup: M. o. G. 2, 1881, p. 37.

Found crystallized in extremely large quantities in cavities and fissures in the red sandstone, about 3 km from the shore in a river bed. The crystals are nearly all perfectly developed with faces on all sides, mostly the usual ones, (10$\bar{1}$0), (10$\bar{1}$1), (01$\bar{1}$1), to which must sometimes be added (11$\bar{2}$1) and a few others. Among the numerous crystals there is not a single fairly regular one; they are all greatly distorted in various ways, most frequently flattened in a direction parallel to a prism or pyramidal face; further they are frequently skeletally developed. It is particularly characteristic that the faces are frequently covered by a number of hematite scales; these may also be found within the crystals, which thus most frequently attain a dark-red appearance. The size may be rather considerable (more than 1 kg).

The older reports of these crystals are not referred to any definite locality, but the mention of the hematite makes it extremely likely that this or the following locality are the ones mentioned. From Ipiutaq Giesecke only mentions white crystals found in granite. Steenstrup was the first to collect greater quantities (1876) and to describe the locality.

Sagdliaruseq (Steenstrup 1899). The occurrence resembles the preceding one by the plentiful presence of hematite, either as scales or as small spherical masses. The crystals are rather small, but very beautifully developed; they are to be found in fissures in sandstone, frequently with the interstices filled with fluorite.

Mussartût. Here both Steenstrup and Ussing have collected samples of a somewhat similar kind as those from Ivínguit. The groundmass also here consists of albite and ægirine, but is far more irregularly composed; the pseudomorphs consist of quartz without ægirine; but as

they have not been found free from the rock, it cannot be seen whether their form is the same.

Narssârssuk (LYTZEN's collection 1893).

FLINK: Geol. Fören. Förh. Stockholm, 15, 1893, p. 207.

FLINK: Zts. Kryst. 23, 1894, p. 365.

FLINK: M. o. G. 14, 1898, p. 229.

FLINK: M. o. G. 24, 1901, p. 17.

STEENSTRUP: M. o. G. 34, 1910, p. 138.

Found almost everywhere in the pegmatite veins, where the great abundance of quartz is presumably due to the melting of the sandstone bounding upon the syenite. Sometimes it fills interstices between the other minerals, sometimes it occurs in crystals which may be up to 1 dm in length; they may be white, untransparent or clear, in a few cases smoke-coloured. Most of the crystals have the usual combination, prism and pyramid; as a rule also $(2\bar{1}\bar{1}1)$ is found. A few of the smaller crystals are richer in faces, partly bounded by rare or quite new faces. The greater part of the crystals are strongly etched, frequently so much so that the form is quite effaced. On the somewhat less corroded crystals regular etching figures are frequently seen; FLINK describes them as isoscele triangles on the pyramids, where I myself have only seen the usual oblique triangles and horizontal triangles on the prism faces, the apex of which is turned to the edge above which $(2\bar{1}\bar{1}1)$ lies.

A greater number of the etched crystals show a very peculiar phenomenon, in that they grow out again so as to produce outstanding areas formed with beautifully reflecting and shining faces, divided by depressions in which the strongly etched face appears.

STEENSTRUP calls attention to a peculiar phenomenon, viz. the occurrence of base (0001) on some of the crystals, which form is otherwise extremely rare. The faces are always very small and very uneven, so that they do not yield proper reflexes; they may possibly have been produced by etching, and on the same crystals similar faces may be found in other directions, which might probably prove to belong to rare faces, if it were possible to determine them more accurately.

Igaliko (RINK).

RINK: Gr. II, App. p. 143.

Here mention is made of a rock crystal of a very considerable size (16 by 10 cm). A number of crystals collected by STEENSTRUP at Iganeq possibly originate from the same locality.

Ilua (SYLOW 1881).

Rose quartz in rather large fragments.

Statenhuk (GIESECKE 26-7-1806).

Here a number of loose crystals (length 4—8 cm) were collected;

they were lying loose on the shore, many of them being perfectly developed with faces on all sides. The combination is the usual one, sometimes with small faces of $(2\bar{1}\bar{1}1)$ and $(6\bar{1}\bar{5}1)$; the faces dull, frequently uneven and curved.

East-Greenland.

Dronning Louises Ø and south of Nagtoralik (Eberlin 1884). Larger fragments of rose quartz.

Døde Hus Plads (Kruuse 1899).

O. Nordenskjöld: M. o. G. 28, 1909, p. 13.

Here mention is made of a large druse with quartz crystals up to an inch in length, besides felspar and some calcite.

Turner Sund (Carlsberg-Exped. to East-Greenl. 1898—1900).

Bøggild: M. o. G. 28, 1909, p. 105.

Here mention is made of a number of various occurrences of quartz crystals, among which special attention is called to one consisting of rather small crystals (1—2 mm wide); these are peculiar in that the only perfectly developed form is the one rhombohedron without other plane faces. See otherwise the treatise mentioned above, in which other quartz forms are described from the same locality, as well as from Kap Dalton and Henry Gletscher; none of these, however, offer anything by way of peculiar interest.

Flakke Bugt and Sabine Ø.

Die 2-te Deutsche Nordpolsfahrt, 2, 1874, pp. 486 and 489.

Smoky quartz, partly fragments of a larger crystal (11 cm) with the usual faces. The colour deep brownishblack.

58. Chalcedony. SiO_2.

C. does not only include c. in the narrower sense of the word, but also all the different forms of microcrystalline silica, even though they should perhaps rather be classed as quartz. C. is, as might be expected, very common in the basalt areas, but on the other hand very rare in other localities. There is hardly any reason to mention all the localities known.

The Umanak district.

Naqerdlok (Giesecke 28-5-1811). Here c. is found in the usual grey colour for the filling of fissures and as crust formation in the columnar calcite; Giesecke speaks of "kubischer und figurirter Chalcedon", and it is quite sure that the projections on the surface are shaped like indistinct cubes with strongly rounded edges; still it is hardly possible to prove that pseudomorphoses of any regular mineral (fluorite seems the most likely) really have taken place.

Vesterfjeld (Rosenkrantz 1938). From blocks of amygdaloid rocks in the basalt conglomerate originates a larger fragment of agate with rock crystals in cavities and another, on the outside consisting of c. with a strong blue fluorescence, inside filled with quartz.

Kangilia. The c. from here is described under quartz.

Angnertuneq (Rosenkrantz 1946). Here a loose-lying geode was found without any rock. There is the following succession of layers: (1) first formed dark-grey c. (1 cm), (2) white fine-grained quartz, (3) grey c. (5 mm) and (4) white, fine-grained quartz (1 mm).

Sangmissoq (Sermesok).

Rink: Ngr., 1852, p. 58.

Large stalactite-shaped masses with quartz and dolomite and moulds of dolomite crystals.

Niaqornârssuk (Eriksen 1939). Here agate was collected with rather irregular layers of whitish or greyish colour. In 1946 Rosenkrantz found chalcedony of the common, semi-transparent grey kind; enclosed in it are globular masses (c. 5 cm in diameter) of dolomite. Next to the dolomite masses of quartz are sometimes to be seen, and in other samples the dolomite is surrounded by large masses of rock crystals. In the same place Rosenkrantz and Skou have, in the plateau basalt, found a very peculiar mass consisting of a black, flint-like groundmass, which under the microscope has the common, fine-grained quartz-structure, and in that mass are lying pure white spheres with a diameter of 2—5 mm, consisting of a very intricate and fine mixture of magnesite and a not determinable, isotropic substance. The spheres are very unevenly distributed, as there are great parts of the mass where they are lying very closely together, whereas in other parts they are totally wanting.

Agatdalen. From here Rosenkrantz in 1938 brought home samples of a bluish-white agate; in 1946 he found black flint with a white crust, resembling very much that which is found in the White Chalk.

The Ritenbenk district.

Kûgánguaq (Giesecke 15-7-1911). Here blue chalcedony is mentioned together with various kinds of agate. Steenstrup has collected a larger agate-amygdale of a milk-white colour, inside filled with quartz. Slightly north of Kûgánguaq Porsild has found a similar, large (20 cm long) agate-amygdale with thin layers of a greyish colour and interrupted by layers of quartz.

Asuk (Steenstrup 1873 and 1898).

Steenstrup: M. o. G. 24, 1901, p. 270.

Characteristic concretions found in columnar basalt; diameter up

to 15 cm. The surface most frequently rather smooth, often finely dotted; the c. itself frequently has fine striae like agate. The concretions are sometimes hollow, with quite small quartz crystals on the walls; but for the greater part the interior is entirely filled with large-grained or columnar calcite. Along the boundary sharp moulds of calcite crystals are frequently seen in the chalcedony, from which STEENSTRUP concludes that the growth of the latter continued after the calcite had been formed. There is, however, the peculiarity that the agate-layers are crossed by the calcite crystals, so that it is the most likely supposition that the calcite is the youngest mineral, which in certain places has grown into the chalcedony, at the same time resorbing the latter.

Qutdligssat (PORSILD 1908). Crusts about 1 cm thick, on the outside grey, half transparent, inside bluish-white. On the walls of the cavity the quartz crystals described on p. 116 are to be found.

The Godhavn district.

Marraq (STEENSTRUP 1872). Lumpy stalactitic formation set with pseudomorphs after a regular mineral, probably fluorite, with the faces (100) and (210). The size of the crystals up to 3 mm. The faces shining, but somewhat curved and irregular.

Skarvefjeld (O. S. PORSILD 1926). At the foot of the slope towards the sea a fragment of basalt was found with a thin (a few mm) crust of c. In a single place on the crust there is a pseudomorph after calcite of the shape $(02\bar{2}1)$, $(11\bar{2}0)$, which must have crystallized before the formation of the chalcedony.

Tarajornitsoq (GIESECKE 27-7-1812). A fragment of green jasper, according to GIESECKE heliotrope.

Eqaluit (RINK). Pebbles of green and brown jasper.

Qarusuit (STEENSTRUP 1898). Small spherical bodies (about 5 mm), whitish in colour, with a rather dull surface; the interior frequently hollow and coated with small shining quartz crystals; on the outside covered with siderite crystals.

Eqalúnguit (ISAK DANIELSEN 1915). Green jasper; on the label PORSILD observes that this stone in Greenlandic is called "angmâq" (ɔ: flint) and is used for arrowheads.

The Christianshaab district.

Akugdleq (GIESECKE 4-10-1807). Mention is made of samples of a heliotrope colour found on the shore; the samples at hand are of a purely dark-green colour. Whereas the green jasper mentioned from the preceding localities is greatly mixed up with an opal substance, the jasper originating from here, when seen under the microscope, is very

pure quartz; it may perhaps be described as plasma. Nothing is known as to its origin.

The Frederikshaab district.

Ivigtut. A form of microcrystalline quartz was found in a boring core from I. It is whitish-brown and looks rather impure, dull and intransparent.

East-Greenland.

Kap Dalton, Henry Bjærg, Turner Sund, Steward Ø (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 106.

In the places named there are found small amounts of different kinds of chalcedony or agate.

Kap Brewster (Scoresby 1822).

Scoresby: Journal of a Voyage, 1823, App. p. 399.

Here mention is made of grape-like c., common c., agate etc.

Geologfjord (Rosenkrantz 1929). In a locality named Spiralkløften (ɔ: the spiral-creek) a great amount of blocks of a dark brownish-red jasper were found in the Pre-cambrian tillite-formation; the microscopic structure is the typical one; a very fine-grained groundmass of quartz substance, in which there is an immense mass of closely packed, small untransparent grains.

Knudshoved in Hold-with-Hope (Rosenkrantz 1945). On the walls of a cavity a layer of c. was first separated, being 3 mm thick; the rest was filled with quartz and a smaller part with calcite. From the basalt above the Senonian in the sam elocality a fragment of agate originates.

Carlshavn (Alex. Jensen 1933). A large fragment (about 3 kg), throughout consisting of a network of c. The diameter of the meshes 0.5—4 cm. The thickness of the walls 0.5—3 mm. C. is grey in colour, with the usual finely fibrous structure. The meshes are filled with opal and smaller quantities of siderite.

Sabine Ø and Pendulum Øer (1869—70).

Die 2te Deutsche Nordpolfahrt, 2, 1874, pp. 489 and 491.

Here mention is made of ordinary c. and blood jasper.

59. Opal. $SiO_2,nHgO$.

Opal has only been found in a few localities in Greenland, mostly in the basalt areas. In the following all known occurrences are described.

The Umanak district.

Nûgssuaq (Rink, Ravn 1909, Rosenkrantz 1946).

Rink: Ngr. 1852, p. 58.

It seems that there is in this place or in the vicinity rather large amounts of opal. It is characteristic that it is only found in limestone, and that the colour is black or very dark-brown. About the occurrence not very much is known.

1) RINK mentions dark-brown, almost black opal which characteristically accompanies the aragonite; no material is left.

2) RAVN collected a large boulder of a brownish-grey, coarse-grained limestone in which a brownish-black opal is embedded; the

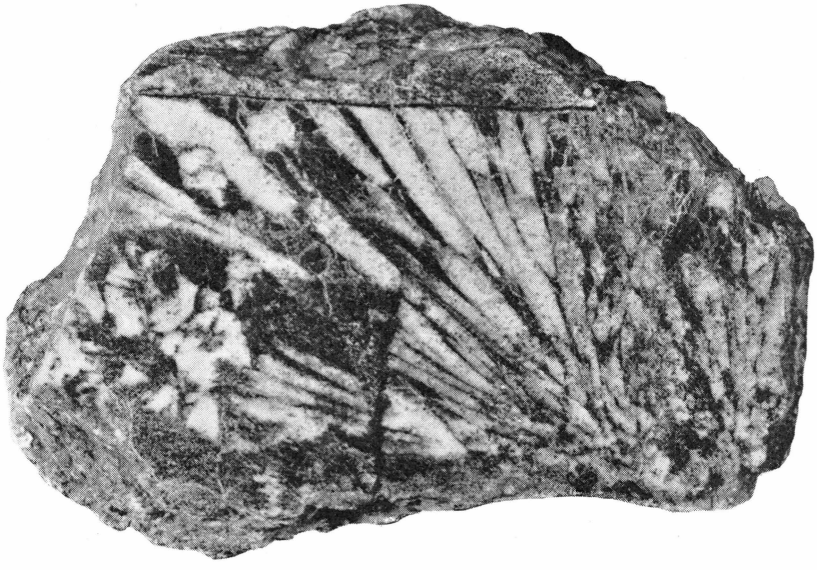


Fig. 19. Opal and calcite. Nûgssuaq. 1:2.

form of the opal enclosures is perfectly irregular, the largest has a diameter of up to 10 cm.

3) ROSENKRANTZ collected a rather large (c. 10 kg) boulder of a very peculiar structure. It is a mixture of a white, fine-grained calcite and an opal which is black and only in thin plates brown in transmitted light. Fig. 19 shows a polished plate of the stone, and we see that it consists of black and white areas alternating, sometimes as more regular parallel bands and sometimes more irregularly mixed. The white areas are rather pure calcite whereas the black areas are a rather intricate mixture of calcite and opal in almost equal quantities. This is shown in fig. 20 which shows a part of a polished face etched with hydrochloric acid; the light is reflected from the surface whereby the opal looks rather light, whereas the calcite is rather dark. Fig. 21 shows almost the same area seen in more vertically infalling light; now the opal is black and the calcite light-greyish, but we see now a very peculiar phenomenon, a lot of white figures, which have first been made visible by the etching

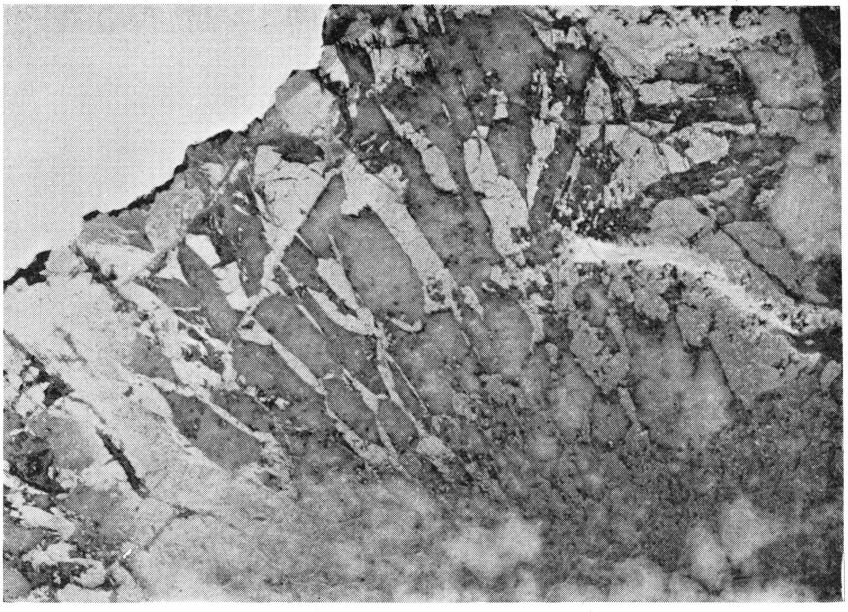


Fig. 20. Opal and calcite. Nùgssuaq. 1:1.

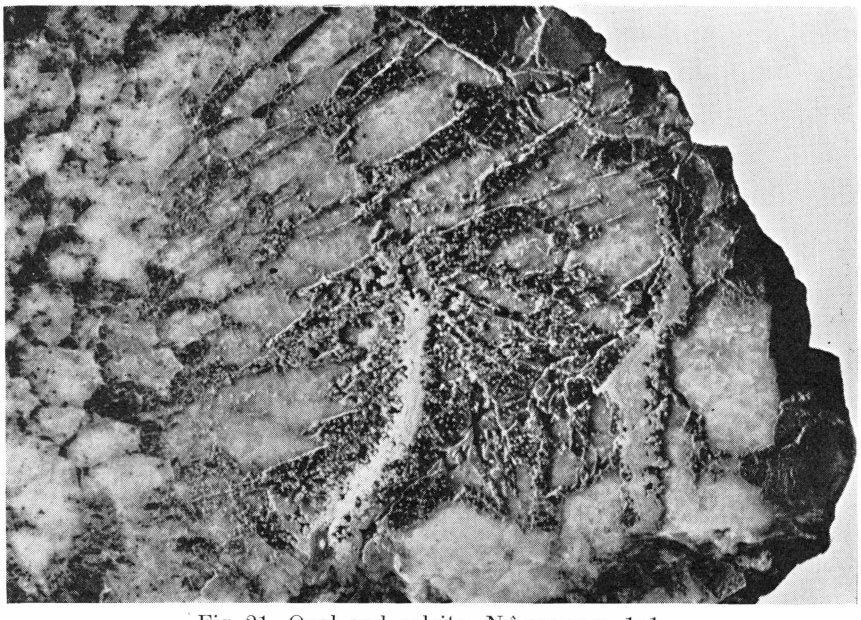


Fig. 21. Opal and calcite. Nùgssuaq. 1:1.

and which consist, as far as can be seen, of a carbonate, either dolomite or magnesite. These figures are 1) a large number of small (c. 0.5 mm) spherical bodies, which are never wanting in the opal, 2) linear figures at the boundaries between the opal and the calcite, and 3) some larger bands through the opal (two of them are seen in the figure).

Hare Øen (STEENSTRUP 1873). Hyalite, very clear, colourless, but with some play of colours in cavities in basalt. In the same locality the Nûgssuaq-Expedition, 1939 found a very peculiar wood-opal, which in the smallest possible degree resembles what is otherwise known of that kind; it consists of quite thin, snow-white fibres, which would a priori be taken for asbestos.

The Ritenbenk district.

Ujaragsugssuk (STEENSTRUP 1872). Half-spherical masses (2—10 mm) found on a thin calcite crust in a cavity in basalt. The opal is semi-transparent, grey or white, milky. It is also found as a hyalite-like formation in a larger cavity.

The Godhavn district.

Per Dams Skib (STEENSTRUP 1898). Found as separate geodes or in layers with chalcedony in basalt; very pure white, with a bluish tinge.

The Julianehaab district.

Ũnartoq (GIESECKE 10-8-1806).

STEENSTRUP: Tillæg B. til Rigsdagstidende 1877—78.

JESSEN, A.: M. o. G. 16, 1896, p. 135.

Very impure siliceous sinter, which forms a 1—2 mm thick coating on loose pebbles round a hot spring. The surface very warty, stalactitic; the colour greyish-white. Specific gravity = 2. Analysis undertaken by JESSEN: SiO_2 54.83, Fe_2O_3 2.52, Al_2O_3 0.92, CaO 16.56, MgO 1.64, Na_2O 0.79, CO_2 8.69, Cl 0.90, SO_3 tr., organic matter and chemically bound water 13.16 = 100.01 ÷ O eq. with Cl 0.20 = 99.81. From this the following distribution of the constituents has been obtained: $CaCO_3$ 19.75, NaCl 1.49, Al_2O_3 0.92, SiO_2 54.83, Fe_2O_3 2.52, MgO 1.64, CaO 5.50, H_2O 13.16. In other words, the sinter is chiefly a mixture of opal and calcite.

East-Greenland.

Carlshavn (ALEX. JENSEN 1933). In meshes in chalcedony (cf. p. 123) opal is separated; in a fresh state it is colourless and transparent, whereas on decomposed faces it is white and untransparent. On such faces the structure of the meshes is very striking, owing to the contrast between the opal and the grey chalcedony, whereas it is very difficult to observe it on fresh faces.

Brinkley Bjærg (Alex. Jensen 1933). Here two different samples have been found: (1) In a black basalt enclosures of a particularly pure and clear, colourless and hyalite-like opal; (2) in a brown basalt a white china-like opal. The latter seems to be rather fresh and can hardly be regarded as a decomposition product of the former kind.

60. Rutile. TiO_2.

The Christianshaab district.

Nûk and the northern side of Kangersuneq (Sylow 1883).

Sylow: M. o. G. 8, 1889, p. 29.

Crystallized with quartz and anthophyllite in a pegmatite vein in gneiss. Dimension 15 by 7 mm. Form prismatic (110) (111), with narrow faces of (100); also a twin of the usual kind was found. The faces very uneven. These two localities must have been mistaken for each other, as Sylow in his treatise mentions the latter locality, whereas the label bears the inscription of Nûk. As this place lies somewhat north of the fjord Kangersuneq, it seems possible to look upon the two places as one locality.

61. Cassiterite. SnO_2.

C. is mentioned from several localities, most of which are, however, very doubtful; the only one which is entirely certain is Ivigtut.

The Umanak district.

Qilertínguit (Giesecke 18-6-1811). Reported to be found interspersed in quartz in loose blocks.

The Godhavn district.

Itivdliarssuk (Giesecke 6-7-1811). From here mention is made of some small twin crystals in grey granite, together with magnetite and apatite.

The Christianshaab district.

Claushavn (Giesecke 28-9-1807). Reported to be found interspersed in gneiss, together with chalcopyrite and malachite.

The Godthaab district.

Fiskenæsset. Crystallized in quartz, partly enclosed in the latter, a few crystals projecting into cavities. Combination: (100), (110), (210), (111), (101), sometimes also (321); the usual twin formation. The faces particularly well developed; the colour varying from light-brown to black. As this is the only sample ever seen, the locality may possibly be considered doubtful.

The Frederikshaab district.

Raadne Klipper [ɔ: rotten cliffs].

RINK: Gr. II, p. 134.

RINK reports that GIESECKE in this locality found c. in a decomposed mass of rock; in the samples brought home by GIESECKE RINK has, however, not been able to find this mineral; so the quantity in which it is found must at any rate have been very inconsiderable. It is peculiar that GIESECKE himself never mentioned the occurrence.

Tuapatsiait east of Arsuk (GIESECKE 15—17 June, 1809). Reported to have been found in very small quantities in granite.

Ivigtut (GIESECKE 10-8-1809).

RINK: Om Monopolhandelen paa Grønland, 1852, p. 99.

HOFF: Vid. Medd. Nat. Foren. 1854, p. 1.

RINK: Gr. II, p. 134, and App. p. 149.

TAYLER: Quart. Journ. Geol. Soc. London, 15, 1859, p. 697. — Manual of Greenland, p. 348.

JOHNSTRUP: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 241.

Found partly in veins in the granite surrounding the cryolite, partly in the large mass of pegmatite west of the principal mass of the cryolite. Here it is found together with cryolite, galena, siderite, arsenopyrite, chalcopyrite, molybdenite, wolframite and zircon. The crystals are at most 2 cm in diameter; they generally occur scattered among the other constituents, and even though, in a single case, continuous, granular masses (about 10 cm in diameter) may be found. It seems that the total amount is very small, for which reason no exploitation of the ore has ever been attempted. The crystals which are most frequently found half grown into quartz, are bounded by (110) and (111) with narrow faces of (101) and sometimes (100). Twins, often also repeated twin formation of common occurrence; the faces are as a rule shining; the two forms (101) and (111) form combination striae with each other.

The colour is black; in the sections very peculiar colour conditions are seen and an unusually strong pleochroism. Whereas ω is colourless or faintly brownish, greenish or reddish, ε varies greatly; it is generally red, from light-rose to a very vivid blood-red, but in certain cases it may also be colourless. All of these shades may occur in the same individual, either in a regular concentrical arrangement or also irregularly mixed, frequently with quite abrupt transitions.

In recent times the physician FALKENBERG ANDERSEN has sent home some samples, showing a very particular manner of occurrence. A large quantity of crystals of very varying size is found enclosed in a mass, consisting of altered siderite, as it seems chiefly consisting of

göthite. That this is due to the alteration of siderite appears from the fact that the particles, which are partly very loosely cemented and partly surrounded by quartz, are still arranged according to the cleavage planes of the siderite, while this mineral itself has completely disappeared. In one of the samples there is at one side a larger individual of siderite, but in this part of the sample there is no c. The cleavage planes continue into the surrounding altered mass.

Qaqortúnguaq west of Ivigtut (GIESECKE 12-8-1809). Reported to have been found interspersed in gneiss.

The Julianehaab district.

Naujat (GIESECKE).
GIESECKE: Catalogue, p. 201. — Manual of Greenland, p. 349.
Reported to have been found as small grains along the shore.

62. Pyrolusite. MnO_2.

The Julianehaab district.

Narssârssuk. Found in the shape of fine fibres, formed in calcite; as to further details see this mineral.

Kangerdluarssuk. Found as small pseudomorphs after enstatite in pseudomorphs after ægirine (for further details see this mineral).

(Anatase).

Among the minerals from Narssârssuk FLINK (M. o. G. 14, 1898, p. 235) mentions a yellow and a white anatase-like mineral. Later investigations have proved the former to be a new mineral, ancylite, whereas the latter is probably zircon.

63. Columbite. $(Fe,Mn)(Nb,Ta)_2O_6$.

The Frederikshaab district.

Ivigtut (TAYLER 1851).
DESCLOIZEAUX: Ann. des Mines 8, 1855, p. 398.
TAYLER: Quart. Journ. Geol. Soc. London, 12, 1856, p. 344.
FORCHHAMMER: 6. Skand. Naturforskermødets Forh., Christiania, 1857, p. 125.
BREITHAUPT: Berg- und Hüttenm. Zeit. 17, 1858, p. 61.
DANA: Amer. Journ. Sci. and Arts, 26, 1858, p. 349.
MÜLLER: Quart. Journ. Chem. Soc. London, 11, 1858, p. 243.
SCHRAUF: Sitzber. d. k. Akad. d. Wiss. Wien, 44, II. Abt., 1861, p. 445.
BLOMSTRAND: Acta Univ. Lundensis, 1865, III. Journ. pr. Chemie, 99, 1866, p. 40.

Hermann: Journ. pr. Chemie, 97, 1866, p. 350. — Bull. Soc. Nat. Moscou, 39, 1866, p. 65.

Hermann: Journ. pr. Chemie, 103, 1868, p. 127.

Brögger: Vid. Selsk. Skr. Christiania, Mat.-naturv. Kl. 1906, Nr. 6, p. 59.

Found crystallized in pegmatite bordering on the cryolite mass; it occurs together with felspar, quartz, mica, siderite, galena, chalcopyrite and molybdenite, whereas it has not been seen in direct contact with cassiterite, which also occurs within the same area. C. is the first-formed of all the minerals and has crystal faces developed in all direc-

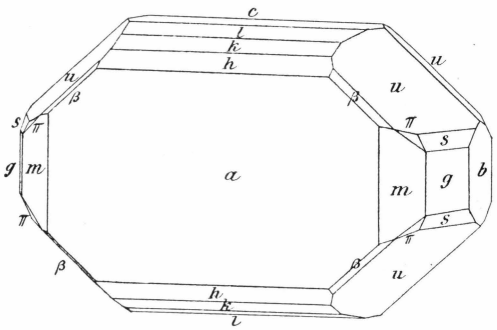


Fig. 22. Columbite. Ivigtut. (After Schrauf).

tions, unless the individual crystals are intergrown, as is very frequently the case. C. has in the course of time been found in very large quantities, and beyond doubt many thousands of crystals have been collected. Their sizes vary from about 2 mm to 2 cm.

The crystals of the Ivigtut columbite have the greatest abundance of faces known; in all, 24 different forms have been described of which, however, many are rare and at the same time rather small and insignificant. One of the most commonly occurring combinations is shown in fig. 21 with the forms: a (100), h (203), k (103), l (106), c (001), m (110), g (130), b (010), β (233), u (133), π (121), s (263). The faces are generally rather well developed and very shining, and in essentials all of them have the same appearance; only quite few specimens show certain peculiarities; thus b (010) has small irregular striæ. The colour is black with a faintly brownish tinge, the streak is chocolate-coloured. When the crystals are broken to pieces, they frequently show concentric rings, formed by an embedded silicate. The specific gravity is 5.37 (according to Oesten[1]), 5.40—5.42 (Müller), 5.395 (Blomstrand). It

[1]) The determination of the specific gravity and the analyses undertaken by Oesten are quoted by several writers; thus Blomstrand and Rammelsberg (Handb. d. Mineralchemie 1875) state that it is found in Pogg. Ann. 99, p. 617.

is chemically peculiar in that it is the only c. which is completely or almost completely free from tantalum, the result of which is i. a. that the specific gravity is less than in other kinds of c. Analyses have been undertaken by FORCHHAMMER (1), OESTEN (2—3), MÜLLER (4), HERMANN[1]) (5) and BLOMSTRAND (6).

	1	2	3	4	5	6
Nb_2O_3 ..	75.19	76.04	77.80	78.74	78.40	77.97
SnO_2 ...	0.47	0.39	0.17	0.16	—	0.73
WO_3....	—	—	—	—	—	0.13
ZrO_2....	—	—	—	—	—	0.13
FeO	16.45	16.91	16.52	16.40	16.41	17.33
MnO....	6.14	4.34	4.95	5.12	4.50	3.28
PbO	—	—	—	—	—	0.12
CuO	1.09	—	—	—	—	—
CaO	—	0.54	0.39	—	—	tr.
MgO....	—	—	—	—	0.60	0.23
	99.34	98.22	99.83	100.42	99.91	99.92

The columbite, found by TAYLER in 1851, was described by BREITHAUPT as a new mineral under the name of "grønlandite". The mistake was, however, soon corrected by the numerous analyses and crystallographic investigations undertaken in the more immediately following period.

64. Euxenite. $(Y,Er,Ce,U,Pb,Ca)[(Ti,Nb,Ta)_2(O,OH)_6]$.

In Greenland this mineral only in one case occurs as accurately determined and analyzed; from a couple of other occurrences a similar mineral is known, but it may just as well be polycrase or possibly other minerals, which can hardly with certainty be distinguished from each other.

The Christianshaab district.

Nûk (RINK).

RINK: Gr. I, 2, p. 207.

Found in quite small (up to 2 mm) irregular grains in quartz together with muscovite. RINK calls the mineral polymignite, but the reactions show that it must either be e. or polycrase.

East-Greenland.

Karra Akungnak (EBERLIN 1884).

EBERLIN: M. o. G. 9, 1889, p. 255.

There is, however, a treatise by OESTEN about c. from Bodenmais in Bavaria, and here nothing is said as to where he has described the results of the above investigations. This also applies to an investigation by MARIGNAC, quoted by HERMANN (the last mentioned treatise) and others, according to which 3.30 % tantalic acid has been found in c. from Ivigtut.

[1]) HERMANN has found 0.56 % tantalic acid.

Crystallized (up to 2 cm) in granite pegmatite. The shape very indistinct, flattened parallel to (010) and also (111), (001), (100) and (110), the last-mentioned very indistinct. The faces very uneven and dull, apparently decomposed. All reactions agree completely with the Norwegian e. Analysis undertaken by CHR. CHRISTENSEN: TiO_2 24.93, Nb_2O_5 30.71, $(Y, Er)_2O_3$ 28.43, Fe_2O_3 3.63, UO_3 9.08, CaO 0.48, Na_2O 0.40, H_2O 2.63 = 100.29. The proportion of quantity of Nb and Ti rather suggests something between e. and polycrase, but various other conditions point more decidedly towards e. EBERLIN called the mineral by the name of polymignite; strangely enough he mentions (Petermanns Mitt. 1885, p. 58) that he has found e. in East-Greenland, but that this information is due to a premature report.

South of Puissortoq (EBERLIN 1884). Small crystals (3—6 mm) in quartz; the form elongated along the c-axis and also flattened along (010), besides (100) and (110) are found, both very indistinct. The faces not particularly well developed. Thin splinters are transparent with a brown colour, and the streak is greyish brown; when heated the mineral becomes brownish. These conditions rather point towards polycrase than towards e.; but as we have no chemical analysis these characteristics are hardly sufficient to distinguish between the minerals from the two nearest occurrences.

65. Fergusonite. $Y(Nb,Ta)O_4$.

The Julianehaab district.

Sârdloq (TAYLER 1856).

TAYLER: Addenda to Giesecke's Catalogue of Minerals.

JESSEN: M. o. G. 16, 1896, p. 125.

From the islands Sârdloq, Igdlorpait and Uvkusik f. is reported to have been found in pegmatite in the shape of irregular grains or indistinct four-sided prisms of up to 4 cm in size, with very shining fractures.

Kangeq on Sermersôq (GIESECKE 9-8-1806).

ALLAN: Thomson's Ann. Phil. 1, 1813, p. 107.

HAIDINGER: Trans. R. Soc. Edinb. 10, 1826, p. 271.

HAIDINGER: Pogg. Ann. 5, 1825, p. 166.

HARTWALL: Kgl. Vet. Akad. Handl. Stockholm, 1828, p. 167.

HARTWALL: Pogg. Ann. 16, 1829, p. 479.

POTYKA: Pogg. Ann. 107, 1859, p. 590.

H. ROSE: Pogg. Ann. 118, 1863, p. 507.

RAMMELSBERG: Ber. Ak. Berlin, 1871, p. 400. — Hdb. Mineralchemie, 1875, p. 361.

Found as small crystals as granite; as to the manner of occurrence

no further information is at hand, any more than of the size of the crystals. Combination: (001), (320), (321), (111). Analyses have been undertaken by HARTWALL (1), WEBER (2, in POTYKA and ROSE) and RAMMELSBERG (3).

	1	2	3
WO_3	—	—	0.15
SnO_2	1.00	0.35	0.47
Ta_2O_2	47.75	—	6.30
Nb_2O_5	—	48.84	44.45
Y_2O_3	41.91	38.61	24.87
Er_2O_3	—	—	9.81
Ce_2O_3	4.68	3.05	7.63[1]
UO_2	0.95	0.35	2.58
ZrO_2	3.02	6.93	—
Fe_2O_3	0.34	1.48	—
FeO	—	—	0.74
CaO	—	—	0.61
H_2O	—	—	1.49
	99.65	99.61	99.10

GIESECKE called the mineral by the name of gadolinite. ALLAN mentions a mineral which resembles allanite in colour, but differs from it by its smooth, shining conchoidal fracture and by the specific gravity = 5. 7604; furthermore, he reports that Dr. WOLLASTON found it to be almost entirely pure yttrotantalite; thus it is very possible that it is the fergusonite he is alluding to. HAIDINGER determined the crystal form of the mineral and, as suggested by ALLAN, gave it the name of fergusonite after ROB. FERGUSON in Raith. Almost at the same time HARTWALL undertook the first analysis of the mineral.

(Yttrotantalite). $Y_4[Ta_2O_7]_4$.

This mineral was first reported by RINK (Ngr. p. 45 and Gr. I, 1, p. 215) from STORØ in the Umanak district; it is said to form thin lamellæ in albite; before the blow-pipe it reacts like y., and an analyses yielded characteristics of rare earths. On closer investigation the mineral, however, has proved to be ilmenite. Further y. is mentioned by ALLAN (Thomson's Ann. Phil. 1, 1813, p. 107), but as mentioned under fergusonite there is every reason to suppose that this is the mineral before us.

(Brucite. $Mg(OH)_2$).

Reported by FLINK (M. o. G. 14, 1898, pp. 247 and 257) as occurring at Nunarssuatsiaq and Tugtup agtakôrfia on the northern side of Tunugdliarfik in the Julianehaab district. The determination is, however, said to be doubtful, and later on the mineral has proved to be epistolite.

---

[1]) Including 5.63 Di_2O_3 and La_2O_3.

66. Diaspore. *AlOOH.*

The Julianehaab district.

The region of Kangerdluarssuk.

Ussing: M. o. G. 14, 1898, p. 141.

Found as quite small, colourless grains or scales in sodalite spreustein. Cleavage and optical conditions prove, with great certainty, that they consist of this mineral.

67. Goethite. *FeOOH.*

The Godhavn district.

Uivfaq.

Löfquist and Benedicks: Jernkontorets Ann. Stockholm, 1940, p. 633.

Found in telluric iron, partly as a constituent of the so-called "oxyde-pearlite" and partly as fine filling of fissures in the iron.

The Frederikshaab district.

Ivigtut. Sometimes found as an alteration product of siderite. Also a few samples have been collected, which consist of thin, partly curved plates, quite loosely joined together. All properties and reactions agree with göthite (lepidocrocite); however, the optical conditions are very peculiar. In sections across the tables interchanging layers of a normally, strong birefringent and an isotropic substance are seen; both are in ordinary light transparent and of a deep-red colour.

68. Limonite. $Fe_4O_3(OH)_6$.

This mineral plays a very inconsiderable part in Greenland. In small quantities it is, it is true, found distributed everywhere, but more considerable occurrences are lacking. In the following a few examples will be given.

The Umanak district.

Svartenhuk (Rosenkrantz 1947). At the sides of a river north of Umîvik near the foot of "Firefjeld" (ɔ: the four rocks) was segregated a layer of a very fine-grained, powder-like limonite. The most peculiar is the colour which is an intensive brownish-red, in opposition to other limonites which are of a pure brown colour; also under the microscope the small particles have a distinct reddish colour. With hydrochloric acid it behaves as other limonites and is very easily dissolved. Analysis by Werner Christensen: Insol + SiO_2 4.5, Fe_2O_3 55.5, Al_2O_3 5.8, Ca 0.0, Mg 0.0, SO_3 3.8, loss at ign. 34.0.

Niaqornat (Giesecke 1811). In a granular calcite, separated in prismatic figures, small (about 1 mm) spherical bodies are found, in particularly great quantities on the faces of the prisms, but also scattered

singly within these. The individual spheres are frequently surrounded by a scale of chalcedony and opal, which divides them from the surrounding calcite.

The Ritenbenk district.

Atanikerdluk.

HEER: Flora fossilis arctica, 1868, p. 10.

Layers in clay-iron stone in the coal-bearing formation; the l. is, when fresh, light-ochreous and contains a great number of mica flakes and quartz grains; analysis undertaken by WARTHA: FeO 3.6, Fe_2O_3 50.1, CaO 0.7, MgO 0.4, CO_2 3.2, H_2O and organic matter 15.6, sand 26.4 = 100.0.

The Godthaab district.

Narssaq (GIESECKE 26-5-1810). From here mention is made of loose fragments of bog ore lying scattered on the surface.

The Frederikshaab district.

Arsuk Storø (GIESECKE 18-6-1806). Loose fragments of limonite are reported to be found in various localities on the island.

The Julianehaab district.

Nunasarnaussaq (Nunasugsuk) (GIESECKE 28-8-1806). Coating on calcite and siderite crystals; also as regularly developed pseudomorphs after siderite rhombohedrons.

V. CARBONATES

69. Magnesite. $MgCO_3$.

The Ritenbenk district.

Kangerdluarssuk (SYLOW 1883). Numerous irregularly shaped grains (up to 1 cm), each consisting of a single individual in talc-schist; m. is more or less penetrated with talc. The colour impure, greyish.

The Godthaab district.

Aunikasik (FÆSTER 1944). Among the many samples collected in this locality (cf. under olivine) there was also one consisting of m. and talc; the two minerals are intergrown in a rather intricate manner, but one side of the sample almost exclusively consists of m. The latter mineral is only found in a single individual, which as a set-off is of a rather considerable size, its diameter being 1 dm or more. No outward crystal faces are found. The colour is brown. Under the microscope it is seen to be penetrated by a great number of very thin needles of anthophyllite. An analysis was undertaken by A. H. NIELSEN: MgO 42.97, CaO 0.30, MnO 0.18, Fe_2O_3 5.02, P_2O_5 tr., insol. in HCl 2.86 (anthophyllite), H_2O (÷ 105°) 0., H_2O (+ 105°) 0.16, CO_2 48.2 = 99.69; further tests were made for SiO_2 (soluble), SO_3, Al_2O_3, FeO, BaO, SrO, Na_2O, K_2O, Cr_2O_3, TiO_2, but none of these substances were found. According to what has been said above, there is no doubt that we are dealing with a very pure m., mixed up with great quantities of limonite and the above-mentioned needles of anthophyllite.

The Frederikshaab district.

Kingigtoq (GIESECKE 1808). A single rather large crystal individual (c. 6 cm) found in more connected cavities in talc. The colour brownish.

70. Siderite. $FeCO_3$.

The Umanak district.

Kaniorqat (GIESECKE 1811). The occurrence is mentioned in detail under calcite. Like this mineral s. forms spherical masses in

granular calcite, aragonite or chalcedony. It is frequently altered into limonite.

The Ritenbenk district.

Atanikerdluk.

HEER: Flora fossilis arctica 1868, p. 10.

Found as clay-ironstone, not only here but also in other localities in the coal-bearing Cretaceous and Tertiary; however, there is no reason to make particular mention of the very homogeneous occurrences, with the exception of this one in which the mineral is found in particularly great quantities, and which has been subjected to the most careful investigations. In a fresh fracture the iron stone is yellowish-grey, fine-grained or microcrystalline, on the surface it is brownish-red. Chemical analyses undertaken by WARTHA are given below: 1 is massive siderite, 2 sandy limonite and 3 fossil wood.

	1	2	3
FeO	32.9	3.6	32.5
Fe_2O_3	26.0	50.1	14.5
CaO	2.6	0.7	3.6
MgO	1.7	0.4	2.9
CO_2	20.1	3.2	26.0
H_2O and org. subst.	13.5	15.6	12.2
Sand	3.2	26.4	8.3
	100.0	100.0	100.0

Nos 1 and 3 thus consist of a very impure siderite, No. 2 of an equally impure limonite.

Igdlukúnguaq (STEENSTRUP 1872). Granular crystalline masses to fill out small cavities in pyrrhotite together with crystals of magnetite.

The Godhavn district.

Qârusuit (STEENSTRUP 1878). Very small (0.5—1 mm) crystals on chalcedony. Form $(01\bar{1}2)$ with greatly curved faces.

The Holsteinsborg district.

Íkátoq Fjord (LASSEN 1876). Numerous small (1—2 mm) brown crystals found in fissures in asbestos, all with the same orientation over an extent of up to 2 dm. Form $(10\bar{1}1)$.

The Godthaab district.

Íkátoq-Quvnilik (KORNERUP 1878).

KORNERUP: M. o. G. 1, 1879, p. 85.

Reported to occur in talc-schist.

The Frederikshaab district.

Arsuk Storö (Giesecke 18-6-1806). Here loose fragments are mentioned, scattered about the island.

Ivigtut (Giesecke 10-8-1809).

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm, 1889.

Steenstrup: M. o. G. 47, 1911, p. 381.

Ford and Bradley: Trans. Connecticut Ac. Sci. 22, 1917, p. 21.

Wherry and Larsen: Journ. Wash. Ac. Sci. 7, 1917.

Hedvall: Geol. Fören. Förh. Stockholm, 47. 1925, p. 73.

Sundius: Ibid, p. 269.

Found crystallized in very large quantities in the cryolite together with numerous other ores, and also in the pegmatite masses which accompany the outermost parts of the cryolite. Of all the minerals found at Ivigtut the siderite seems to be the one, after the cryolite itself, which occurs in the greatest quantities. The relative ages vary somewhat; as a rule the siderite is formed before the cryolite, for which reason it has regular crystal faces, but on the boundary between those two quite irregular faces sometimes are visible, which point towards having grown at the same time. S. is nearly contemporaneous with most other minerals, though e. g. the pyrite and the quartz are most frequently formed before the former. It is a peculiar circumstance that s. is found arranged in layers in the cryolite, parallel with its outer boundary towards the granite; but upon the whole the distribution is quite irregular, and a few parts of the cryolite are entirely free from s. and other enclosures.

The crystals of s. from Ivigtut are presumably the largest existing of this mineral; as a rule they are not more than 1—3 cm, but a few specimens attain individuals up to 4 dm and from such very large and regular cleavage fragments may be obtained. The shape is exclusively $(10\bar{1}1)$; sometimes there is a strong parting parallel with $(01\bar{1}2)$ which has been produced by twin formation. The colour is in various shades; the crystal faces as a rule well-developed, plane with a fine, dull lustre, thus being easily distinguishable from the cleavage planes, which have here a rather strong pearly lustre.

Steenstrup has examined the special conditions of the colour and lustre of the mineral. Whereas the mineral is normally light-brownish with an ordinary vitreous lustre, it is in other cases black or reddish, with a strong metallic or adamantine lustre. When examined under the microscope there proves, at an early stage, to be thin yellow films, which subsequently become thicker, red and at last as black masses may have displaced the original mineral. The films more particularly follow the cleavage-planes of the mineral. Steenstrup has isolated the films and caused an analysis to be made by Chr. Christensen, the

result being: Fe_2O_3 86.4, H_2O 14.1. The films are transparent with a rather pure red colour; they are faintly birefringent and rather seem to be biaxial, positive, with the optic axes lying at some distance from the range of vision.

Even though the process as a rule tends towards what has been mentioned above, and must thus be considered an oxidizing process, it is also possible, as proved by STEENSTRUP, to find fragments in which the opposite seems to have been the case i. e. a light outer zone, which towards the centre gradually merges into a dark colour, but such a fragment may presumably by exception have been placed in a reducing liquid.

Analyses together with determinations of the specific gravity and refraction of the mineral from Ivigtut have been undertaken by FORD and BRADLEY (1) by WHERRY and LARSEN (2), and by BYGDÉN (3, in HEDVALL) with the following results:

	1	2	3
Sp. gr.	3.951	3.94	3.927
ω	1.872	1.871	1.873
ε	1.634	1.632	1.633
$FeCO_3$	95.9	93.49	94.80
$MnCO_3$	4.1	5.16	4.63
$MgCO_3$	—	0.62	0.42
$CaCO_3$	—	0.	0.14

Íka (NYEBOE 1915). From this locality we have a specimen, which chiefly consists of siderite and also contains great quantities of labradorite. Where s. occurs alone, the size of its grains is 1 cm, but where it has been mixed with labradorite, both are rather fine-grained. The colour of the s. is black-brown. When seen under the microscope it proves to be penetrated by dark striae, which follow the cleavage directions, and are presumably owing to decompositions.

The Julianehaab district.

Nunasarnaq (GIESECKE 1806). Crystallized into small (about 5 mm) rhombohedral crystals in cavities in a light, fine-grained rock, together with calcite scalenohedrons and rock crystals. S. is coated with limonite, and sometimes it is entirely decomposed.

Narssârssuk.

FLINK: M. o. G. 14, 1898, p. 250.

A more detailed investigation has proved the s. mentioned from this locality to be rhodochrosite.

Nunasarnaussaq (GIESECKE 28-8-1806 and 20-7-1809). Reported to be found crystallized together with quartz, chalcedony, calcite and fluorite in veins, which in the former place are said to penetrate gneiss, in the latter greenstone.

Tasermiut qíngua (HARTZ 1889). In a small fragment of crocidolite from the moraines of the Inlandice isolated spots of granular

s. were found. The colour light-brown, on the surface dark-coloured owing to the secretion of limonite.

East-Greenland.

Carlshavn, cf. chalcedony, p. 123.

71. Rhodochrosite. $MnCO_3$.

The Julianehaab district.

Narssârssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 250.

Flink: M. o. G. 24, 1901, p. 27.

The mineral which was originally described as siderite has, on closer investigation, proved to be r. It is found in small (2—3 mm) crystals, the black colour of which shows that they are not fresh. There are two types:

1. $(10\bar{1}1)$ and $(11\bar{2}0)$. The faces are generally rather shining. The rhombohedral angle is measured at 75°5′ and 75°7′, but the angles cannot be very accurate, as the faces are not plane. The outer side of the crystals consists of a hard, brittle shell and the interior of a black earthy mass; there is no trace of the original mineral.

2. $(10\bar{1}1)$ alone. The faces very dull, the interior part frequently loose and earthy; sometimes somewhat firmer so that it has been possible to produce cleavage fragments, and on those the angles 74°13′ and 73°46′ have been measured. The freshest material was analysed; it consisted of fragments which were, however, quite black and contained loose detritus. The specific gravity 3.666. The result of the analysis was: MnO 57.06, FeO 15.76, CaO 2.68, O, CO_2, H_2O determined as difference 24.50 = 100.00. It seems that all the crystals originally had a similar composition, but the greater part is transformed to oxides of manganese and iron.

72. Calcite. $CaCO_3$.

There are naturally an infinitude of occurrences of c. in Greenland. By far the greater number of the crystallized forms occur in the basalt areas in West- and East-Greenland, whereas they are comparatively rare in the Precambrian formations. In certain newer parts of the latter considerable layers of marble may occur, e. g. in the so-called Agpat-formation in the region round Umanak; however, they are mostly not very interesting in this connection, and therefore they are not included in the following, any more than the far too inconsiderable crystallized occurrences. For brevity's sake the faces are described by the letters generally used according to the following schedule: *c* (0001), *m* (10$\bar{1}$0), *a* (11$\bar{2}$0), *r* (10$\bar{1}$1), *M* (40$\bar{4}$1), *e* (01$\bar{1}$2), *f* (02$\bar{2}$1), *v* (21$\bar{3}$1); all other forms are indicated by their symbols.

The Upernavik district.

Prøven (Kleemann's collection 1902).

1. Crystallized on coarsely columnar aragonite; the acute scalenohedron (5491) with small faces of (0772). The crystals are about 1 cm large; the faces irregular and dull, the colour yellowish-grey.

2. Crystallized on the wall of a large hemispherical cavity; the greater part of c. is coated with a layer of small rock crystals. The size of the calcite crystals is about 1 cm. Comb. *c*, *f*, and *μ* (5491) (fig. 23); the faces of *f* are quite shining, the others quite dull, so that it has

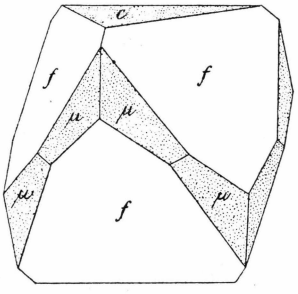


Fig. 23. Calcite, Prøven.

only been possible to determine the scalenohedron by pasting bits of glass to the faces. The colour faintly yellowish.

The Umanak district.

Svartenhuk (Rosenkrantz 1947). North of Umîvik at the foot of "Firefjeld" there was found a calcareous tufa as segregation from a hot spring; most of it was a fine powder which contained numerous coarser particles, mostly as thin plates. The colour white. Analysis by Werner Christensen: Insol. 16.8, CO_2 31.4, CaO 40.1, MgO 1.5, Fe_2O_3 2.2, Al_2O_3 0.75, SO_3 1.54.

Marmorilik (Noe-Nygaard 1939). The marble which is worked in the quarry only partly consists of calcite, being a great part dolomitic. The marble contains many inclusions of foreign minerals, among which especially may be noted the large ore body mentioned p. 43. Scattered around in the marble we find pyrite and sphalerite, and of other minerals tremolite seems to be the most widespread; talc and mica in very small leaves are possibly pseudopseudomorphs after the tremolite; furthermore are found scapolite, fluorite and graphite. The marble is mostly fine-grained, more rarely coarse-grained with calcite individuals up to 5 cm or more.

Niaqornat. A fragment of columnar c. together with quartz is mentioned on p. 115. At Niaqorssuaq, east of Niaqornat Sole Munck in 1946 collected fibrous calcite in veins (up to 3 cm thick) which were

placed vertically in slate from the contact between picrite and breccia. The colour is grey with darker and lighter bands alternating. The fibres are very regularly arranged, whereas the optic axes are placed quite at random. At Qâqap Qârssua south of N. thin veins of fibrous c. have been found, and in the same locality fragments with cavities, the walls of which are coated with spherical groups of pectolite, on which a single apophyllite crystal and several smaller crystals of c. The shape is very nearly cubic, but the faces are not so well developed that they can be accurately measured. There is a negative rhombohedron, probably $(03\bar{3}2)$. At Tuperssuartait, west of N., Skou collected numerous rather large (up to 5 cm) crystals in cavities in basalt. Form *e*. The crystals are well developed with rather even but dull faces; white and semitransparent.

Sangmissoq (Giesecke 30-6-1811). C. is found in cavities in basalt together with small crystals of laumontite and sometimes also of stilbite. The calcite crystals are large, up to 15 cm long and exclusively bounded by *f* with very irregularly undulating and curved faces. The crystals semi-transparent, brown.

Kaniorqat (Giesecke 30-6-1811).

This locality and a couple of the following ones present very peculiar conditions, both as regards the association of the carbonates occurring together and also with respect to the form in which they occur; as to the geological conditions nothing is known, except that the carbonates have been segregated in basalt, which also occurs in some of the fragments, but as to the form of the beds nothing is known, no more than of their size; however, judging from the quantities of fragments brought home, they cannot have been quite inconsiderable. The samples most frequently have a ground-mass with a number of spherical enclosures. The ground-mass is generally a coarse granular or columnar aggregate, consisting either of calcite or aragonite. The masses enclosed may occur in a very irregular shape, such as crusts or the like, but they are most frequently shaped as very regular spheres, of a diameter of from a few mm to about 1 dm. They consist of radiating elements with a very pronounced concentric structure, so that smaller spheres may frequently loosen from the surrounding layers. Sometimes there is a layer of chalcedony between the ground-mass and the spheres, and in cavities in the ground-mass calcite crystals (*e*) may be found. The spheres either consist of calcite or siderite (possibly limonite) with all the four combinations of the two minerals of the ground-mass with the two minerals of the spheres.

Nûgssuaq (Rink).

Rink: Ngr. p. 58.

From this occurrence, which is rather close to the preceding one, originates a single specimen of the same kind as that described above, with calcite spheres in a calcitic ground-mass (fig. 24). As it seems

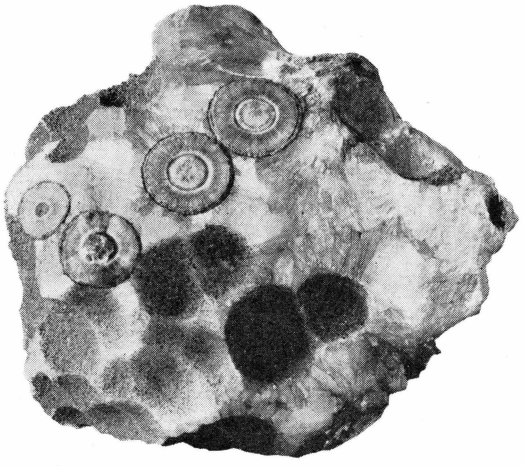


Fig. 24. Spheres of calcite in calcite. Nûgssuaq. 1:2.

rather rare that concretionary formations are segregated in surroundings of exactly the same nature, I caused analyses to be made of both in the manufactory "Øresund". (1) is the analysis of the spheres, (2) that of the ground-mass.

	1	2
SiO_2	1.16	0.18
Al_2O_3	0.48	—
Fe_2O_3	0.20	0.26
FeO	3.72	0.65
MgO	2.25	0.61
MnO	1.45	3.21
CaO	47.72	51.82
H_2O	0.11	0.05
CO_2	41.81	43.10
	98.90	99.88

With the exception that there are a few more impurities in the calcite from the spheres, which are also a little darker, viz. more brownish than the white ground-mass, it is hardly possible to speak of a different composition of the two substances.

In the same occurrence is also found basalt-breccia with a thin coating of c. From the interior of the Nûgssuaq peninsula Porsild has sent in a fragment of sandstone, the surface of which is coated with a thin layer of c.; according to the label this formation is said to be found on the undersides of all boulders on the top of a tuff mountain.

Hare Øen, south of Erqua (Th. Porsild). Here a formation has been found somewhat resembling those from the two preceding localities, a granulous calcite in which small irregularly shaped masses of brown, somewhat iron-bearing calcite.

Hare Øen, Aumarûtigssat (Steenstrup 1872). Small acute rhombohedrons ($08\bar{8}1$), together with levynite in basalt.

The Ritenbenk district.

Qutdligssat (O. R. B. Hansen). Fibrous c. in a layer 2 cm thick. The fibres very regular, and the boundaries between the individuals also closely follow the direction of the fibres, whereas the optic axes are placed at random in relation to the latter.

Ujaragssuit (Steenstrup 1872). Crystals, up to 5 cm in length with levynite and analcite in basalt. Form *a* and ($08\bar{8}1$). The faces curved, dull, the colour dark-brown.

The Godhavn district.

Orpît qáqât in Disko Fjord (Sole Munck 1939). Found as columnar and radiating aggregates in heulandite; the length of the columns is up to 5 cm. Most peculiar is the colour which is dark-brownish and in thinner splinters brown or yellow; the optic axes are orientated exactly parallel with the direction of the columns.

East of Nordfiord. Lat. 69°45′ N. Long. 53°40′ W. (Aksel Frandsen 1946). Loose-lying fragments of crystals, up to three cm. Bounded by the prism *a*, no terminal faces; colourless and transparent.

Kronprinsens Ejland (Pjetursson 1879). Irregularly granular anthraconite; the colour purely black.

The Egedesminde district.

Isuarmiut (Giesecke 1812). Cleavage fragments (about 8 cm) with very numerous twin lamellæ along *e*, in which direction there is also a parting and a rather strong pearly lustre; the colour yellowish or greyish.

Akugdlît (Sylow 1883).

Sylow: M. o. G. 8, 1883, p. 28.

Here mention is made of layers of violet calcite, about 13 cm thick in salite.

The Holsteinsborg district.

Sarfánguaq (S. Hansen 1888).

Snow-white, uneven crusts on gneiss (thickness up to 2 mm)

The Godthaab district.

Kolinguaq (RINK). Larger individuals filling out interstices between epidote and garnet. The colour white.

The Frederikshaab district.

Tuapatsiait (GIESECKE 15.-17. July, 1809). Crystals (1 mm—5 cm) in a dark-grey slate. Form *r* with rather imperfectly developed, uneven and dull faces. The colour whitish.

The Julianehaab district.

Josva's Copper Mine (HOFF 1863). A few individuals (up to 6 cm) for the filling out of cavities between rock crystals found on granulous quartz together with bornite. Whitish, opaque.

Ivnatsiaq (HOFF 1863). A single cleavage fragment with small chalcopyrite crystals.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, pp. 230 and 236.

FLINK: M. o. G. 24, 1901, p. 24.

BØGGILD: M.o.G. 33, 1907, p. 98.

Found in syenite-pegmatite veins, nearly always crystallized; the following types may be distinguished:

1. *r* sometimes with a subordinate *a*. The size up to 2 cm. The faces dull; the crystals rather disintegrated with a brown surface, whereas the interior is white.

2. The scalenohedron $(43\bar{7}4)$. 2—3 mm, the colour yellowish-grey or brown.

3. *c*, *r*, (*a*) $(35\bar{8}2)$ and (*β*) $(08\bar{8}5)$, the faces *c* and (*β*) are small, but shining and well-developed; those of *r* are dull and corroded; those of (*a*) are the largest; they are shining but very uneven. The crystals are colourless, rather transparent; they occur together with a previously formed analcite.

4. *c* and *f*, both equally developed, thus producing an octahedron-like figure, for which reason they were in the first-mentioned treatise regarded as a new mineral under the name of colourless octahedrons. The size 1—2 mm; the faces plane, but rather dull with a brownish surface.

5. Very small crystals (1—2 mm in length), bounded by *c*, *r*, *f*, $(44\bar{8}3)$ and $(6.10.\bar{16}.1)$.

After the publication of the above-mentioned treatises a couple of other forms have been found.

6. Crystals 1 cm in length, bounded by *c*, *f* and *a*; the colour brownish, the faces rather dull.

Further, some characteristic cleavage fragments have been found, up to 5 cm in diameter. The colour dark-brown or black; the faces strongly curved. In sections it proves that the substance is more or less interlarded with a network of black fibres, probably of pyrolusite; the fibres partly follow the cleavage directions of the calcite, but for the greater part they have an irregular course. In hydrochloric acid the whole is dissolved, while chlorine is given off.

A few calcite crystals are entirely altered to pseudomorphs of elpidite. The largest of these is 5 cm long and 2 cm wide, thus being the largest calcite crystal from Narssârssuk. Even though the faces of the pseudomorphs are extremely uneven, it is difficult to mistake the form which is characteristic of calcite (*r*, *a*, *v*).

Nunasarnaussaq (Giesecke 28-8-1806). Crystallized together with siderite and small rock crystals in cavities in a fine-grained, light-coloured rock. Form *v*, somewhat irregularly skeletal with dull, rounded faces; the colour yellowish-white.

Inuarugdligaq (Jessen 1894).

Jessen: M. o. G. 16, 1896, p. 125.

The occurrence consists of a diabase dyke, about 2 m thick; it is cleft in the middle, and the fissure is filled with clay, in which calcite crystals occur, projecting from calcite layers, which coat both side walls. The calcite is in great requisition among the Greenlanders, who mix it with snuff; otherwise softer materials only occur in small quantities in this part of the country. Form *c*, *m*, colour yellowish.

Orkusaq in Unartoq (Jessen 1894). The occurrence has something in common with the preceding one; the label states that the crystals are found in clay in a fissure in granite. Form like the preceding, but as distinguished from these with very uneven faces; the colour yellowish. The size rather considerable; a single crystal which was, however, not collected in that locality, but was handed in by one of the inhabitants, attains a width of 16 cm and is the largest calcite crystal known from Greenland.

East-Greenland.

Iluileq (Sylow 1881). A fissure in granite, 8 cm wide, is almost entirely filled with large-grained calcite in different varieties, yellowish, reddish or colourless. In the middle there are cavities with crystals (*a*, *r*, *M*, *f*, *e*) frequently regularly developed, frequently flattened along a face of the prism *a*, and in that case also often twins on *e*, which is further elongated parallel with the zone *a*:*r*:*e*. The faces are very differently developed, those of *r*, *f* and *M* are particularly fine, level and shining, *e* is deeply striated parallel to the edge towards *r*, and *a* is also

striated parallel to the edge towards *r*. The crystals clear, transparent and colourless.

Between Kiataq and Kap Löwenörn (Eberlin 1884).

Knutzen and Eberlin: M. o. G. 9, 1889, p. 244.

Here flesh-coloured c. is mentioned, in several localities segregated in fissures and cavities in gneiss.

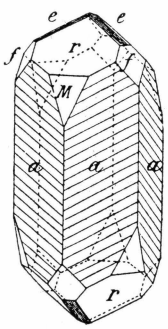


Fig. 25. Calcite. Iluileq.

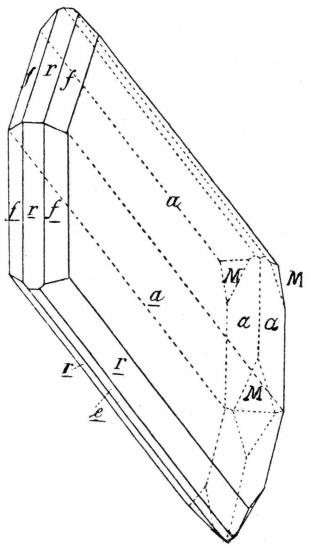


Fig. 26. Calcite, twin on e (01$\bar{1}$2). Iluileq.

Tiniteqilâq in Sermilik (Kruuse 1901). Large (up to 2 dm), irregularly shaped individuals enclosing rounded quartz crystals and small hexagonal graphite-scales. Semi-transparent, whitish.

Kap Dalton (O. Nordenskjöld 1900).

Bøggild: M. o. G. 29, 1909, p. 107.

A single fragment of granular quartz with deep and regular imprints of calcite crystals (*f*); of the calcite itself nothing is left.

In the same paper are described different occurrences of calcite from the same expedition, such as Henry Bjærg, Turner Ø and Kap Brewster; furthermore the south side of Gaasefjord (Hartz 1892) and Danmarks Ø (Bay 1892). All these occurrences are, however, rather insignificant and shall not be mentioned in detail here.

Kap Hope (Rosenkrantz 1927). In the coast section to the east of K. H. an, irregularly rounded concretion of about 1 dm in diameter has been collected in a Prerhaetic conglomerate; it consists of columnar calcite, very impure, of a reddish or a greyish colour.

Kap Brown (O. Nordenskjöld 1900). In a very fine-grained quartzite abounding in mica numerous calcite crystals of very varying size (up to 5 cm in diameter); sometimes very closely packed. Form, as far as can be seen, exclusively *r* with very uneven faces. Brownish white.

Ella Ø (Noe-Nygaard 1932). At Langesø near Kap Oswald rather large (up to 0.5 kg) cleavage fragments of calcite have been found, having been embedded in light-grey dolomite from the youngest Pre-cambrian. Whitish, opaque.

East of the station veins (10—15 mm thick) have been found in schist, also of the youngest Pre-cambrian. Opaque, the colour light-brown. The structure very irregular and coarsely columnar.

Kap Broer Ruys and Sabine Ø.

Lenz: Die 2te Deutsche Nordpolfahrt 2, 1874, pp. 485 and 489.

Here mention is made of scalenohedral crystals without any description of the occurrence.

Falske Bugt (1870).

Lenz: Ibid. p. 487.

Coarse-grained crystalline limestone forming layers in gneiss; the colour white. Analysis undertaken by Stingl: $CaCO_3$ 97.32, $FeCO_3$ 1.01, $MgCO_3$ 1.70, SiO_2 0.10, P_2O_3 tr. = 100.13.

Pendulum Øer (1870).

Lenz: Ibid. p. 491.

From here mention is made of a whitish rhombohedron (5 cm) with fine twin striae; further in a basalt amygdaloid crystals of a pure yellow colour and finally lime tufa.

Kap Stosch (Alex. Jensen 1933). Between the two rivers east of K. S. which by Eigil Nielsen (M. o. G. 98, 1) are called River 13 and 14, crystals have been collected in fissures in a hard limestone bench above the *Posidonomya* shale, about 200 m above sea level. The size 1—2 cm, form *e* with small faces of *m*; the faces dull, the substance white, only slightly transparent. From River 14 originate a few larger cleavage fragments.

Kap Stosch (Poulsen 1929, Rosenkrantz 1945). In a locality called Raukelejren near the Imaqaq valley east of K. S. a number of calcite crystals were found in fissures in Permian conglomerate, partly rather large and well-developed; the largest crystal, which is only a fragment, attains a length of 8 cm. The only form is the scalenohedron v, frequently with quite plane but dull faces. The crystals colourless, rather clear and transparent.

Hochstetters Forland (Rosenkrantz 1945). On fissures in the Eleonore Bay formation crystals were found, partly together with

pyrite; the largest crystals attain 5 cm in diameter. Most of them are only bounded by the cleavage rhombohedron *r*, but on a single specimen there was a combination of *e* with small faces of *a*. The faces well-developed, but dull; they are frequently coated with a rather loose crust of a not accurately definable carbonate.

The same expedition collected (Sole Munck) a good deal of cleavage-fragments (up to 1 kg), reported to come from grey dolomite east of Kulhus on the coast cliff. The substance white, almost untransparent.

73. Dolomite. $CaMg(CO_3)_2$.

D. is found in several localities in Greenland, mostly as a rock embedded in the Precambrian formations. Most of the older records will be left out in the following, as the correctness of the determinations is doubtful; also most localities are left out, where d. only occurs as a rock. The names of the faces are like those used in the case of calcite.

The Thule district.

Carey Øer (Krarup-Schmidt 1881). Fine-grained concretion-like masses with very small insignificant calcite crystals on the surface. The form very irregular, the surface deeply indented and grooved. Further, coarse-grained d. has been found with small calcite crystals in fissures.

North Star Bay (Mylius-Erichsen 1903—04). Here various forms of the mineral have been collected. Besides fragments of an ordinary dolomitic rock fibrous d. is found with extremely regular fibres, which have here a quite irregular optical orientation; further, a more coarsely columnar sample, with a number of calcite individuals intergrown with the dolomite, and with a number of small pyrite crystals enclosed. Finally, there is a specimen with a characteristic mixture of d. and barite. Part of the specimen is impure, microcrystalline, pierced by very thin veins of fibrous d.; from these areas there is a transition through microcrystalline material to a rather coarse-grained mass, which is rather clear and colourless.

The Umanak district.

Angnertuneq (Rosenkrantz 1946). In calcareous shale is found a very fine geode with the following succession: 1) a layer of white calcite (1 mm), 2) a layer of dark brown dolomite (2 mm) and 3) white calcite, filling out the whole interior.

Niaqornat (Rink). Greyish or greenish, large-grained dolomite with crystals in cavities; size about 1 cm; form *e* with dull and curved faces. Also from this region Rosenkrantz in 1938 brought home large quantities of the mineral. From the "marble-contact" under the picrite in

Røde Kløft (ɔ: red ravine) originates a sample with numerous crystals (*e*) in cavities. Somewhat farther west, at Tuperssuartait similar crystals have been found, though essentially larger (up to 3 cm).

Niaqornârssuk (Rosenkrantz 1946). Globular masses (c. 5 cm) in quartz and chalcedony; sometimes the d. is dissolved and has left impressions of crystals in the surroundings. The structure of the d. is coarse and radially columnar, the colour is brownish-white.

The Christianshaab district.

Kangerdluluk (Rink). Grey, granulous impure d. containing very numerous small graphite scales and tremolite prisms, besides lens-shaped talc masses and pseudomorphs after pyroxene. The pseudomorphs consist of the same constituents as the surrounding rock, viz. d. with graphite and larger quantities of tremolite, which are partly orientated along the crystal form of the pyroxene.

The Egedesminde and Holsteinsborg districts.

Akuliaruserssuaq and the northern bank of Nagssugtôq (Pjetursson 1897).

Eqalugssuit, Ujaragsugssuit and Ungôriarfik (Kornerup 1870).

Kornerup: M. o. G. 2, 1881, p. 154.

Pjetursson: M. o. G. 14, 1898, p. 291.

In the localities mentioned above dolomite veins are found, chiefly consisting of a coarse-grained, greyish-white rock containing olivine, chondrodite, spinel, phlogopite, graphite and frequently large masses of serpentine. In some localities, as e. g. at Eqalugssuit, the dolomite merges into limestone. Analyses have been undertaken by Johnstrup (in Kornerup): 1. The layer north of Eqalugssuit large-grained, greyish-white, specific gravity 2.863; 2. layer at Ujaragsugssuit, fine-grained, yellowish-grey, specific gravity 2.771; 3. layer west of Ungôriarfik, large-grained, greyish-white; specific gravity 2.852.

	1	2	3
$CaCO_3$	57.78	72.75	57.24
$MgCO_3$	38.80	7.45	39.71
$FeCO_3$	2.07	3.36	2.00
insol.	0.54	15.87	0.59
	99.19	99.43	99.54

Nos. 1 and 3 are thus fairly pure dolomite, no. 2 is richer in lime and foreign intermixtures.

A discussion between the authors as to the connection between the different veins is hardly of any but purely local interest, and will therefore be left out here; neither is the exact position known for all localities.

The Godthaab district.

Qarajap Ilua (Steenstrup 1888). A single crystal individual extending through several inter-connected cavities in asbestos. Size about 10 cm; the colour brownish.

The Frederikshaab district.

Tayler's Havn (Thomsen 1869). Very coarse-grained aggregate (sizes of grains up to 1 dm), enclosing small grains of hematite. The colour light-brownish.

East-Greenland.

Traill Ø (Noe-Nygaard 1932). In a place called Maanedalen on the northern side of the island is found a boulder consisting of a geode, the main part of which is fine-grained white dolomite, with fragments of a quartzitic rock of dark-grey colour. Besides there are contemporaneous quartz-inclusions throughout the dolomite. Most characteristic is a zone (c. 5 mm thick) consisting of 5 thin layers of small quartz crystals separated by 4 layers of dolomite.

Kap Franklin (Rosenkrantz 1929). A dolomitic vein (up to 4 cm thick) in dislocated yellowish-grey Devonian sandstone. The vein is separated from it by a strong reddish layer, and also the interior is partly penetrated by ferrugineous matter, thus becoming parti-coloured (red and white). The structure is rather fine-grained, the individuals 2—5 mm in diameter.

From the same locality and the same expedition originates a peculiar formation, which is described in details under gypsum. D. is found scattered in the latter, but mostly in definite, fairly continuous layers. It consists of irregularly rounded grains (about 0.01 mm), each forming one individual.

Falske Bugt (1870).

Die 2te Deutsche Nordpolfahrt 2, 1874, p. 487.

Granular in layers in gneiss with limestone and dolomitic limestone containing graphite flakes and pyrite. Specific gravity 2.825. Analyses undertaken by Stingl: CaO 29.65, MgO 21.23, FeO 0.75, Fe_2O_3 0.08, MnO 0.04, CO_2 46.98, insol. 0.65 = 99.38; the remainder consists of Na_2O, S, H_2O. The rock is thus dolomitic lime: 62.6 % $CaCO_3$ and 32.0 $MgCO_3$.

(Ankerite).

The existence of a. is not yet proved with certainty in Greenland. From an older period it is mentioned by SCHUMACHER[1]) without further indication of locality; he writes that coarse-grained a. is found in rolled fragments, coated and penetrated with "Eisenkalk"? This statement is quoted by LEONHARD[2]).

74. Aragonite. $CaCO_3$.

A few occurrences have been found in the basalt areas, none outside the latter.

The Upernavik district.

Prøven.

RINK: Ngr. p. 60.

Segregated in cavities in the basalt as a coarse columnar aggregate: the individuals are up to 15 cm long and 3 cm wide; of accompanying minerals only calcite is found in a single case. Sometimes crystal faces (110) and (010) have been developed without terminal faces; numerous twinlamellæ. Rather clear and transparent of a greyish or yellowish colour.

The Umanak district.

Between Serfat and Ikorfat (ROSENKRANTZ 1946). Spherical bodies (almost 4 cm in diameter) in basalt breccia, not accompanied by other minerals, excepting small amounts of an aphanitic, white, undeterminable zeolite. The structure of the a. is regularly columnar and radiating, the colour is brownish. The optic axis a is parallel to the axes of the columns.

Niaqornat (RAVN 1909). Thin (about 1 mm) veins of a. in a graphitic rock: the a. is accompanied by small amounts of zaratite. A. possesses a fibrous structure with very regular, parallel fibres; the optical orientation is exactly like the one mentioned above, and it seems that this property is characteristic for the a. whereas the optic axes in fibrous calcite, often quite at random.

Kaniorqat (GIESECKE 30-6-1811).

STROMEYER: Göttingische gelehrte Anzeigen, 1819, p. 1998.

Reported by GIESECKE to have been found in a granulous and foliated form and also as small spheres; the latter are, however, not present in the material of the Mineralogical Museum of Copenhagen, where (as mentioned under calcite) a. is only seen as ground-mass between spheres of calcite and siderite. Analysis undertaken by STROMEYER: $CaCO_3$ 98.5278, $SrCO_3$ 0.7403, FeO and MnO 0.2181, Al_2O_3 0.1817, quartz 0.1363, H_2O 0.1272 = 99.9314.

[1]) Versuch eines Verzeichnisses der in den Dänish-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 21.

[2]) Handbuch einer allgemeinen topographischen Mineralogie, 1805, p. 145.

Nûgssuaq (Rink).

Rink: Ngr. p. 58.

A. fills out veins in the basalt as large, columnar masses together with dolomite; the individuals have a length of up to 25 cm and a width of up to 5 cm. There are numerous crystals, which it is difficult to loosen unbroken from the surrounding dolomite. Form (110), (010) and (011) with numerous twin lamellæ. The colour brownish and greyish.

Aumarûtigssat on Hare Øen (Giesecke 1807). Found as a white silky aggregate filling fissures in tuff, and besides as a coarser columnar, radiating reddish or greyish aggregate, sometimes with crystals projecting freely with (110) and (010) without terminal faces.

The Ritenbenk district.

Kûgánguaq (Giesecke 14-7-1811). Here massive a. is mentioned, together with quartz, chalcedony, mesolite etc. in tuff.

Ritenbenk Coal-mine (Giesecke 17-7-1811). Reported to occur together with asbestos-like zeolite (wollastonite) in fine-grained tuff.

The Godhavn district.

Igpik (Giesecke 17-7-1811). Here mention is made of needle-shaped a. (igloite) together with mesolite, stilbite, green earth, calcite and other minerals in basalt.

East-Greenland.

Turner Sund (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 109.

Found as a brownish radiating aggregate in a cavity in basalt, the walls of which are coated with small rock-crystals.

Hold with Hope (Rosenkrantz 1945). North of the hunting hut in Tobiasdal, at a height of 200 m were found small (about 1 cm) round geodes in basalt, filled with groups of radiating a., in each geode radiating from a definite point in the surface. Further a few rather large fragments were found, each consisting of a single individual, penetrated by very thin twin lamellæ. The cleavage faces are not particularly pronounced. The substance is white, almost opague, which must probably be due to gas inclusions, as not the least bit remains, when the mineral is dissolved in acid.

Flakke Bugt.

Lenz: Die 2te Deutsche Nordpolfahrt, 2, 1874, p. 486.

Here mention is made of whitish, radiating and columnar a.

Sabine Ø.

Lenz: Ibid. p. 489.

Here mention is made of very beautiful fillings for cavities, consisting of white prismatic a.

Shannon Ø.

LENZ: Ibid. p. 494.

Reported to be found in a mass of radiating crystals, white, with strong vitreous lustre.

75. Cerussite. $PbCO_3$.

The Julianehaab district.

Narssârssuk.

GORDON: Proc. Ac. Nat. Sc. Philad. 1924, p. 261.

C. is as it seems a fairly constant companion of galena in this locality; it is found as white crusts, consisting of verysmall crystals on the galena.

76. Azurite. $Cu_3[(OH)CO_3]_2$.

The Godthaab district.

Fiskenæsset (GIESECKE 17-5-1809) reported to be found together with chalcopyrite and malachite in a quartz vein in granite.

The Julianehaab district.

Josva's Copper Mine (RINK).

RINK: Gr. II, App. 149.

Thin coating on chalcocite and bornite.

Fr. VII's Mine (GIESECKE 1806). Like the preceding mine.

East-Greenland.

Wegeners Halvø (NOE-NYGAARD).

NOE-NYGAARD: M. o. G. 103, No. 1, 1934, p. 30.

Reported to have been identified as secretions in limestone found as boulders at a place called Tvekegledal; the mineral partly consists of small masses on the walls of fissures, partly of very thin (about 1 mm) fillings of fissures. The mineral is accompanied by smaller quantities of malachite.

77. Malachite. $Cu_2[(OH)_2CO_3]$.

M. has been found at a number of localities in Greenland, but always only in very small quantities. There is hardly a single copper occurrence, where m. does not likewise occur, and such occurrences will therefore only exceptionally be mentioned in the following, where a few reported occurrences of m. will be mentioned without other copper minerals having been found.

The Upernavik district.

Grisebugt (ɔ: pig's bay) (GIESECKE 17-7-1807). Here quartz fragments coloured by m. are reported to have been found.

The Umanak district.

Akia on Storø Giesecke 21-4-1811). Reported to have been found as a coating on hornblende schist.

The Holsteinsborg district.

Eqalugârssuit at Itivdleq (Porsild). On fragments of amphibolite there was a thin, but very strong green layer of m. The label states that the colour is visible at a long distance.

The Sukkertoppen district.

Itivdlínguaq in Søndre Strømfjord (Nyeboe). Here secretions of gypsum are found, coated by a thin layer of m.

The Godthaab district.

Igdlorssuit (Giesecke 12-8-1808). Together with white felspar in chlorite.

Pisigsarfik (Giesecke 18-8-1808). Very widely distributed on hornblende- and mica- schist.

Qilaussa (Giesecke 20-9-1808). Is reported to have been found in mica schist.

The Frederikshaab district.

Ivigtut. Although this locality must be regarded as one of the places richest in copper in Greenland, m. has only been found in extremely small quantities as a coating on thomsenolite, hagemannite, pachnolite etc.

The Julianehaab district.

Josva's Copper Mine (Rink). Found in comparatively large quantities as a coating on chalcocite and bornite.

Julianehaab (Giesecke 10-7-1806). Is reported to have been found in faint traces on granite.

East-Greenland.

Wegeners Halvø (Noe-Nygaard 1931).

Noe-Nygaard: M. o. G. 103, Nr. 1, 1934, p. 30.

Found as small (up to 5 mm) irregularly formed masses in boulders; at a place called Tvekegledal, the m. is accompanied by azurite, at another place, Vimmelskaftet, by cuprite.

(Parisite.) $CaCe_2(CO_3)_3F_2$.

As to the occurrence of this mineral see the following.

78. Synchysite. *Ca(Ce,La,Di)[F(CO$_3$)$_2$]*.

The Julianehaab district.

Narssârssuk (Lytzen Collection 1893).

G. Nordenskiöld: Geol. Fören. Förh. Stockholm, 16, 1894, p. 338.

Flink: M. o. G. 14, 1898, p. 233.
Flink: M. o. G. 24, 1901, p. 29.
Flink: Bull. Geol. Inst. Upsala, 5. Part 1, 1900, No. 9.
Bøggild: M. o. G. 33, 1907, p. 99.
Palache and Warren: Amer. Journ. Sci. 31, 1911, p. 533.
Quersigh: Rendic. R. Acc. d. Lincei fis., mat. e nat. Cl. 21, 1912, p. 581.
Aminoff: Geol. fören. förh. Stockholm, 42, 1920, p. 291.
Oftedal: Zts. Krist. 79, 1931, p. 437.

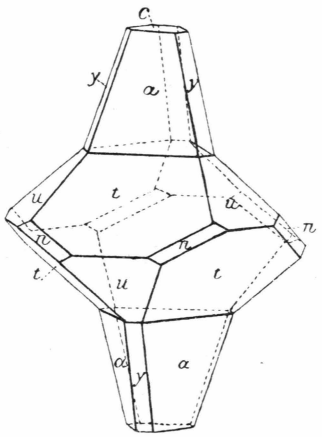


Fig. 27. Synchysite. Narssârssuk. After Flink.

Found in large quantities in the pegmatite veins at Narssârssuk, principally as quite small crystals of an elongated pointed form, 1—2 mm in length, about 0.5 mm in width, bounded by a rhombohedron a $(30\bar{3}2)$ and base. The larger crystals have a very, unusual shape, tapering at both ends and bounded by the two above-mentioned forms and γ $(03\bar{3}1)$ whereas they are swollen in the middle part and bounded by several other forms, such as t $(20\bar{2}9)$, u $(02\bar{2}9)$ and n $(11\bar{2}0)$, as shown in fig. 27, but these and the other faces in the middle part of the crystals are so badly developed that they can hardly be determined with certainty. It is not even easy to determine to which class of the hexagonal system they belong; most of them seem to be rhombohedral, but in others the hemihedrism is not so pronounced, and some of them seem, as described by the author, also to be hemimorphous.

The largest crystals are more or less skeletally developed, as much as 6 cm long and 3 cm thick. It is characteristic that the base, as opposed to the other faces, is always glossy and shining. The colour is grey to brown; the central parts of the larger crystals are generally ash-grey and opaque; the other parts semi-transparent; under the microscope

the central part shows a concentrice arrangement of different coloured layers. The hardness is $4^1/_2$, the specific gravity 3.90. Analyses have been undertaken by NORDENSKIÖLD (1, on 0.0966 gr), FLINK (2) and MAUZELIUS (3, in FLINK, the last-mentioned treatise).

	1	2	3
CO_2	23.0	26.54	25.99
ThO_2	—	—	0.30
Ce_2O_3	52.1	28.14	21.98
$(La_2, Di_2)\ O_3$		22.88	28.67
Y_2O_3	2.5	1.23	1.18
Fe_2O_3	2.2	—	FeO 0.11
Al_2O_3	0.7	—	—
CaO	12.2	17.13	16.63
Na_2O	1.5	0.19	—
K_2O	0.7	0.12	—
F	[5.1]	5.82	5.04
H_2O		—	2.10
	100.0	102.05	102.00
O		2.45	2.12
		99.60	99.88

Before the blow-pipe s. is infusible, and it dissolves slowly in H Cl with effervescence.

S. has only been found crystallized; it occurs most frequently together with neptunite, epididymite, ægirine, orthoclase etc. which are all older than s., and also with albite, elpidite, fluorite, cordylite and polylithionite, which are younger than or contemperaneous with s.

The literature relating to s. largely tends to prove whether it is identical with parisite or not. In NORDENSKIÖLD's treatise and in that first mentioned by FLINK, the mineral is simply called parisite; in FLINK's second treatise he has arrived at the result that the minerals must be different, but the investigations of the original parisite from Muso were not sufficiently accurate. However, already in the same year there appeared a work[1]) which, together with a description of the mineral from a new locality, also mentioned new investigations of the original mineral. After that FLINK established the mineral from Narssârssuk as a new mineral, which he called synchysite from a Greek word meaning mistake of identity, and he mentioned the following 5 points which should distinguish the two minerals from each other.

1. The chemical composition leading to different formulæ viz. $(CeF)_2Ca(CO_3)_3$ for p., $(CeF)Ca(CO_3)_2$ for s.

2. The cleavage often seen in p. is parallel to the base whereas quite fresh s. has no distinct true cleavage.

[1]) PENFIELD: Amer. Journ. Sci., 4. Ser., 8, 1899, p. 21.

3. The specific gravity in s. 3.902, in p. 4.364.

4. Indices of refraction in s. $\omega = 1.6742$; $\varepsilon = 1.7701$; in p. $\omega = 1.569$; $\varepsilon = 1.670$.

5. The crystal form in s. rhombohedral, in p. hexagonal.

Palache and Warren are of the opinion that the comparatively great difference in the chemical composition of the two minerals does not agree very well with the rather small difference in the physical conditions, and that the former difference may perhaps be explained by the supposition that the Greenland material may be partly disintegrated. The crystals from the new occurrence Quincy, which is described by Palache and Warren, show rhombohedral hemihedrism like the specimens described by Flink. Quercigh investigated the refraction of both minerals and found that they were nearly exactly alike; further he determined the Ca-contents of quite fresh material from Narssârssuk and found 11.96 %, or nearly the same as in parisite, and he thus arrived at the result that the two minerals are identical. By means of Laue-diagrams Aminoff also arrives at the result that the minerals are identical. On the other hand, Oftedal has made röntgenographic investigations, by which means the structure of the minerals was determined with a fair degree of certainty; it proved that they had different elementary cells, even though they were constructed more or less according to the same ground-plan. The name s. ought thus to be maintained and also used, not only about the Greenland mineral, but also about the material from some of the other localities.

79. Cordylite. $Ba(Ce,La,Di)_2[F_2(CO_3)_3]$.

The Julianehaab district.

Narssârssuk (Jessen 1894, Flink 1897).

Flink: M. o. G. 14, 1898, p. 236.

Flink: M. o. G. 24, 1901, p. 42.

Bøggild: M. o. G. 33, 1907, p. 101.

Oftedal: Zts. Krist, 1931, p. 437.

Found in the shape of small crystals in the pegmatite veins, but not in particularly large quantities. The crystals are hexagonal, bounded by base, prism and various pyramids; frequently the crystals are developed in such a manner that the prism faces are found at the lower end, whereas the upper end is bounded by the pyramids and somewhat swollen, the crystal thus rather resembling a club in shape (hence the name). A common form with the faces m $(10\bar{1}0)$, r $(20\bar{2}3)$ and p $(4.0.\bar{4}.15)$ is shown in fig. 28. The faces are very different in quality; the base is always clear and shining and so are, to a somewhat lesser degree, the faces immediately adjoining it. The cleavage parallel with the base;

the hardness $4^1/_2$; the specific gravity 4.31. The colour may vary from nearly white to brownish-yellow, but in general it is pale yellow, which makes the crystals rather striking in spite of their being so small. The older crystals described by FLINK are only in part clear and transparent, and their cross-section has a regular zonary structure; later formed crystals, described by the author, are quite clear with beautifully developed faces and without the usual club shape. On these crystals the refraction has been determined: $\omega = 1.7640$, $\varepsilon = 1.5772$; negative

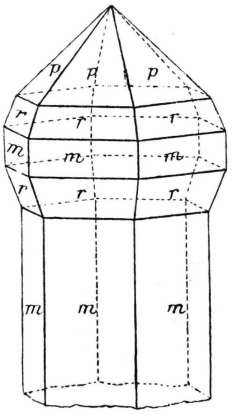


Fig. 28. Cordylite. Narssârssuk. After FLINK.

birefringence. There may be a faint pleocroism: ω greenish yellow, ε brownish yellow.

Analysis undertaken by MAUZELIUS on 0.6489 gr: CO_2 23.47, ThO_2 0.30, Ce_2O_3 23.72, $(La, Di)_2O_3$ 25.67, Y_2O_3 tr., FeO 1.43, BaO 17.30, CaO 1.91, H_2O 0.80, F_2 (4.87), insol. 2.58 = 102.05 ÷ 0 = 2.05 = 100.00. This composition corresponds fairly well with a formula: $Ce_2F_2BaC_3O_9$.

Before the blow-pipe c. decrepitates violently, cleaving into thin plates parallel with the basal cleavage; c. is infusible, with hydrochloric acid reaction for barium. It is easily soluble in acids.

C. has only been found at a single locality in the pegmatite veins, and upon the whole not in particularly large quantities; it frequently occurs together with ægirine, into which it is partly grown, also often together with synchysite, neptunite and ancylite, and it seems to be the last formed of the minerals in that locality. The crystals are always very small, generally less than 1 mm; the greatest are 3 mm in length and 1 mm in width.

In his first preliminary report FLINK called the mineral pseudo-parisite, and only after a detailed investigation it was given the name of cordylite (barium-parisite), which name was used in the second treatise.

The relationship between these minerals has been investigated in detail by OFTEDAL, who by means of röntgenographical investigations finds that the structure of c., it is true, is related to that of parisite and synchysite, but still deviates so much from it, that there cannot be any question of isomorphism.

C. has not been found outside Greenland.

80. Trona. $Na_3H(CO_3)_2 \cdot 2H_2O$.

The Umanak district.

Qapiortoq kitdleq in the great valley Auvfarssuaq in the interior of Nûgssuaq (ROSENKRANTZ 1946). Found at the surface of a mud-volcano as an incrustation consisting of c. 80 % earth and 20 % salt. An analysis of the part which is dissoluble in water was undertaken by WERNER CHRISTENSEN with the following result: Cl 10,4, SO_4 7.1, CO_3 24.4, HCO_3 21.7, Na 36.4 = 100.0. From this we may conclude that the trona forms most of the mixture. Under the microscope are seen a great quantity of small (up to 0.01 mm long) prisms of that easily recognisable mineral.

81. Zaratite. $Ni_3[(OH)_4CO_3] \cdot 4H_2O$.

The Umanak district.

Slibestensfjeld (ɔ: grinding stone mountain) (ROSENKRANTZ 1939). The specimen which, as is stated on the label, has been taken near the picrite contact consists of sandstone with grains of quartz in a graphitic cement; on the surface there are thin crusts of z., of a light-green colour.

Niaqornat (RAVN 1909). The samples consist of impure graphite with thin crusts of fibrous aragonite, which also forms veins in the graphite; on the aragonite there are here and there small quantities of z.

The Ritenbenk district.

Igdlukúnguaq (STEENSTRUP 1871). Found as a quite thin coating on nickel-bearing pyrrhotite. It chiefly consists of small, warty masses with an uneven surface; the colour is vividly emerald green.

82. Ancylite. $Sr_3(Ce,La,Di)_4[(OH)_4(CO_3)_7] \cdot 3H_2O$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 235.
FLINK: M. o. G. 24, 1901, p. 49.
GORDON: Proc. Ac. Nat. Sc. Philad. 77, 1925, p. 1.

The crystals are rhombic, and FLINK regarded them as a combination of two domes (101) and (011), which are always strongly curved so that the angles can only be inaccurately measured; the crystals are placed under the microscope with the zones to be measured in a vertical position, and then as far as possible every single face parallel with the branches of the hair-cross. GORDON arrives at a somewhat different result; when the crystal is placed in the goniometer, it is observed that the faces of (011) yield two reflexes which, it is true, are connected with a continuous series of reflexes, but nevertheless stand out rather clearly, and this I have also been able to observe on the better crystals. GORDON choses the arrangement that FLINK's (011) is made (111), whereas (101) is made (120).

There is no distinct cleavage. The hardness is $4^1/_2$, the specific gravity 3.95. The colour is brownish or yellowish in various shades, the substance is semi-transparent, which is due to innumerable enclosed ægirine needles. The refraction is according to GORDON: α 1.625, β 1.700, γ 1.735, of which 2 V is calculated = 66°. The sign is negative. Analysis undertaken by MAUZELIUS (in FLINK): CO_2 23.28, ThO_2 0.20, Ce_2O_3 22.22, (La, Di)$_2O_3$ 24.04, Y_2O_3 trace, FeO 0.35, MnO trace, SrO 21.03, CaO 1.52, H_2O 6.52, F trace, insol. 0.60 = 99.76. This agrees fairly well with the formula $(CeOH)_4Sr_3(CO_3)_7 . 3H_2O$.

Before the blow-pipe a. is infusible; heated in the closed tube it gives off water abundantly. With hydrochloric acid reaction for Sr. Easily soluble in acid.

Ancylite occurs exclusively in a crystallized form, the larger (up to 4 mm); the crystals as a rule completely developed in an entangled mass of needle- or hair-shaped ægirine, also together with albite and zircon crystals. The smaller imperfectly developed individuals as a rule form continuous crusts and may have grown together into a loose texture which often, in an entirely clean state, fill out cavities between other minerals such as felspar, ægirine and other minerals. This form is also found together with cordylite, and of these two a. seems to be the oldest.

A. which was first found by FLINK in 1897, was in the first report mentioned as two new minerals, under the preliminary names "yellow anatase-like" and "small, light-coloured octahedrons". Not until these minerals were investigated in detail, it was proved that they belonged together.

A mineral closely related with a., "calcioancylite", has been found on the Kola Peninsula; part of Sr has been replaced by Ca. A couple of similar minerals, maganese-lime-a. and iron-lime-a. have been found in loose blocks in Western Russia (the actual locality not being known); as they do not contain Sr the relationship with a. is presumably very remote.

VI. SULPHATES AND TUNGSTATES

83. Mascagnite. $(NH_4)_2SO_4$.

The Umanak district.

Pujortoq (Rosenkrantz 1938). Among the sublimate products yielded by the burnt shales mentioned on p. 32 there are also samples of sulphate of ammonium; this mineral is found in the shape of a white powder, which under the microscope proves to consist of elongated crystals of a refraction like chlor-benzene (1.522) with parallel extinction and negative birefringence in the longitudinal direction. This in connection with the chemical properties and the very strong volatility makes it undoubtful that we are dealing with the mineral in question.

84. Thenardite. Na_2SO_4.

The Holsteinsborg district.

Itivdleq Valley at the end of I. Lake (Pjetursson 1879).

Pjetursson: M. o. G. 14, 1898, p. 337.

Found as a thin, white crust on the slopes towards a brook in a sand terrace. Analysis undertaken by Chr. Winther: Na_2O 28.19, K_2O 4.99, CaO 3.21, MgO 3.48, SO_3 44.31, Cl 9.07. Furthermore, about 3 % were found to be dissoluble in hydrochloric acid, more particularly iron and phosphoric acid, further Al_2O_3 and water. The constituents mentioned above can presumably be put together in various ways, but it is at any rate a fact that the sodium sulphate must constitute more than half of the whole, and as the amount of water cannot be sufficient to form the mirabilite abounding with water, which besides t. is the only natural sodium sulphate, the salt in question must necessarily be t.

Itivneq (J. A. D. Jensen 1884).

Jensen: M. o. G. 8, 1889, pp. 51 and 61.

White, crystalline powder, which was found in very thin layers on a clay plain. Analysis undertaken by Rørdam: SO_3 46,07, Cl 8.02, CO_2 0.78, $(Fe, Al)_2O_3$ 2.55, MgO 2.72, Na_2O 30.09, K_2O 0.91,

H_2O 8.76 = 99.90. The composition is very nearly the same as in the preceding mineral, but the analysis can hardly be quite correct, as the oxygen corresponding with the amount of chlorine has not been deduced. In addition the amount of acid is too great in proportion to the bases to form the neutral salts, which must surely be supposed to have been present.

85. Anhydrite. *$CaSo_4$.*

East Greenland.

West of Kap Franklin (Rosenkrantz 1929). In a mass resembling alabaster, which will be described under gypsum (p. 170) a large quantity (up to half) of a. is found. The mineral has in the main its own crystal form and appears in the thin sections as rectangular plates up to about 0.1 mm in length.

Smaller quantities of the mineral are also found in other localities in East Greenland gypsum.

86. Barite. *$BaSO_4$.*

The Thule district.

North Star Bay (Mylius-Erichsen 1903—04). Originating from here is the specimen mentioned under dolomite (p. 149) and consisting of a mixture of b. and dolomite. In the coarse-grained part the individuals attain a diameter of about 2 cm. The b. is rather opaque and of a white colour.

The Umanak district.

Kangilia (Eriksen 1939). Occurs together with whewellite (see this mineral) and calcite in an echinide shell. The grains are up to 1 cm in diameter; as a rule no crystal faces are developed, only in a single case faces of (011) have been found. The colour darkbrown, the substance clear and transparent.

The Frederikshaab district.

Ivigtut.

Bøgvad: M. o. G. 92, No. 8, 1933.

Here mention is made of some columnar aggregates, which besides b. contain thomsenolite, fluorite, topaz and a new fluoride, besides other minerals i. a. the new mineral jarlite. A more detailed description of this extremely interesting combination of minerals will be given later on.

In a single specimen forwarded in 1926 by the "Kryolitselskabet Øresund" and chiefly consisting of jarlite, with a number of other minerals intermixed, a single skeleton-crystal of barite was found; it was about

1 dm in extent, semi-transparent and whitish. The faces very imperfectly developed and for the greater part concealed by other minerals. It is peculiar that numerous fine enclosures are found, arranged parallel with (100) in which direction a rather strong silver-like reflection is emitted somewhat resembling a cleavage face.

In the thin sections of this mixture of minerals are seen fairly numerous grains of a mineral with rather characteristic properties; the diameter of the grains may attain about 1 mm. The mineral is colourless and very pure; the birefringence is very great; the refraction is in a pulverized material found to vary from about 1.46 to about 1.54. The mineral is biaxial, negative. The strong birefringence, it is true, points towards the mineral being a carbonate, but this is excluded, as the mineral does not dissolve in hot acid. It is hardly possible to find any other mineral with similar properties, and the quantity of the material does not permit of any attempt to isolate it so as to determine it accurately.

The Julianehaab district.

Mussartût, in the neighbourhood of (Steenstrup 1899). Found in cavities in the red sandstone, in the shape of impure large-grained masses (size of individuals up to 4 cm). Opaque, greenish white with red veins.

Igaliko (Rink).

Rink: Gr. II, App. p. 149.

A single small fragment, which is said to have been brought by a Greenlander from the region of Igaliko, may possibly originate from the same locality as the preceding one.

East Greenland.

Canning Land (Noe-Nygaard 1929). Aggregates, the single individuals of which are 1—2 cm broad, 1—2 mm thick; the substance is very impure, penetrated by a number of small particles; the colour varies from brownish white to rusty.

Wegener Halvø (Eklund 1934). In two different localities on the western side viz. Tvekegledal and Vimmelskaftshus small samples of barite veins have been collected, in both localities of exactly the same appearance, large-grained, without other minerals and of a yellowish- or reddish white colour.

Kongeborgen (ɔ: the royal castle) (Rosenkrantz 1929). In a loose block of red Devonian sandstone were found irregularly radiating masses of a very impure b. In the sections it shows a strongly undulating extinction, without definite boundaries between the individuals. The colour most frequently impurely red, more rarely whitish. An analysis undertaken by A. H. Nielsen yielded: Ba 55.01, Sr 2.45, SO_4 40.63 = 98.09.

Finsch Øer in the Gael Hamkes Bugt (Sigurd Hansen 1929). A fragment of a large block in a conglomerate consisting of an aggregate of barite crystals, which in most respects greatly resemble those from the preceding locality; no other minerals were present, excepting rounded quartz-grains scattered in the barite. In cavities were found a few crystals bounded by (001) and (110), sometimes also narrow, but well-developed faces of (111).

Wollaston Forland (Noe-Nygaard 1929). In a locality called Cardioceras Valley a fragment of a crystal was found, 2 cm wide and 3 mm thick. It is bounded by (001) and (110), and there were also a few other very small and not accurately definable faces. The faces are upon the whole very far from level. Transparent with a faintly greenish colour.

87. Carphosiderite. $HFe^{III}_3[(OH)_6(SO_4)_2]$.

In 1900 this mineral was almost only known from Greenland, but it has later on been proved that this or similar minerals have an extremely wide distribution. At the same time, it has however become a matter of doubt whether c. is an independent mineral, or whether it is to be referred to jarosite or possibly to other minerals. Outwardly it is very insignificant, forming crusts of a brownish or a yellowish colour; common to them all is the fact that they give iron, sulphur and water reactions, but an accurate determination can, in each single case, only be obtained by a chemical analysis, which in many cases will perhaps not be sufficient, as the material does not always seem to be particularly pure. I have therefore given up determining the various Greenland occurrences and will in the following deal with them as a single mineral.

The Upernavik district.

Langø (Rink).

Rink: Ngr., p. 217. Found in graphite-bearing gneiss as a thin crust-like coating with numerous stalactitic and warty projections of a size of up to 1 cm. Rink describes the mineral as an ochreous crust.

The Umanak district.

Akia on Storøen.

A loose gravelly or sandy mass, consisting of various minerals which are all coated with loose, yellowish or brownish c.

The Godhavn district.

Fortunebay (O. R. B. Hansen). Brown crusts found on hornblende schist; the substance very hard and rather pure with small stalactites on the surface.

The Egedesminde district.

Sungaussaq (Sylow 1883). Is reported to have been found as a coating on the rock; it forms lumpy and stalactitic masses with a very

fine-grained surface. Thickness up to 2 cm. The colour at the surface dark brownish, becoming lighter farther in. The specific gravity 2.905.

The Holsteinsborg district.

Holsteinsborg (FÆSTER). The fragment consists of a rock, penetrated by large masses of limonite on which there is a crust of c., projecting like rather large, very irregular stalactites. The colour brownish.

The Sukkertoppen district.

Qeqertatsiaq (J. A. D. JENSEN 1885). Forms a coating on the cliff, consisting of lumpy masses (up to 7 cm thick) with a warty and gritty surface. Sometimes purely straw-coloured, sometimes darker, brownish. Specific gravity 2.707.

The Godthaab district.

Akajamineq. From here there are some rather thin crusts of a greyish-brown colour.

Greenland, locality not specified.

BREITHAUPT: Schweigger's Journ. f. Chem. u. Phys. 50 (= Schweigger's Jahrb. f. Chem. u. Phys. 20), 1827, p. 314.

PISANI: Compt. Rend. 58, 1864, p. 242.

Very little is known as to the conditions under which the mineral described by these two authors occurs. BREITHAUPT, who is the first to name it after the Greek words for straw and iron, states that his material originates from Labrador; it has been given to him by the Moravian Brethren in Herrnhut, who have stations both in Greenland and on Labrador, for which reason these two places may easily have been mistaken for each other. However, chemical investigations undertaken by HARKORT (in BREITHAUPT) led to the result that the mineral was a hydrated iron-phosphate, and as there is thus a possibility that it is neither the one now called c. nor originates from Greenland, it will not be dealt with in greater detail.

However, PISANI got hold of two fragments of minerals, one from KOELBING'S collection originating from Herrnhut, the other from ADAM'S collection in Paris, both fragments being labelled Greenland. PISANI analysed the mineral and demonstrated that it was a hydrated ferric-sulphate, but he was of the opinion that it must be identical with the mineral described by BREITHAUPT, the chemical composition of which had been erroneously determined. In the Mineralogical Museum of Copenhagen some very solid and lumpy specimens are found, being labelled "South Greenland" and a single one "Godthaab"; this, however, does not yield very reliable information, as Godthaab, the "capital" and mission station of Greenland, might easily be used for specimens from anywhere in South Greenland. PISANI'S analysis yielded the result: SO_3 25.52, Fe_2O_3 40.00, MnO trace, sand 14.78, gypsum 9.03, H_2O 14.67. The sand and the gypsum having been deduced the figures arrived at are: SO_3 31.82, Fe_2O_3 49.88, H_2O 18.30.

88. Hexahydrite. $MgSO_4 \cdot 6H_2O$.

The Umanak district.

Turritella Kløft (ɔ: ravine) (Rosenkrantz 1946) in the interior of Nûgssuaq, about 20 km south of Ikorfat h. was found as crusts, up to 1 cm thick, upon black shales from the Paleocene. The surface highly uneven, warty and stalactitic. The colour is in the lower parts of the crust grey, in the higher parts snow-white. The analyses have proved that the mineral is a hydrated magnesium sulphate, and the optical constants, such as refraction, double refraction and the negative, biaxial signs show that the mineral is either h. or epsomite; as the last-named mineral, however, always possesses a distinct fibrous structure, of which the mineral in question does not show the least trace, it must, after all probability, be classed as hexahydrite.

89. Melanterite. $FeSO_4 \cdot 7H_2O$.

The Umanak district.

Akia on Storøen (Giesecke 24-4-1811). Is reported to be found as snow-white hairs in heaps of sandy clay; it is uncertain whether the determination is correct.

Kûk.

Schumacher: Nat. Selsk. Skr. 4. Bd. 2. Hefte, 1798, p. 230.

Rink: Ngr. 1852, p. 230.

Found together with pyrite in the coals; according to Rink there is also a hydrated ferro-sulphate, however, without any definite information as to its determination and composition. M. is found as a loose mass in the shape of fine, silky needles; it is greenish yellow and rather impure.

The Frederikshaab district.

Arsuk-Storø (Giesecke 18-6-1806). Is reported to form a coating of the banks of the rivers.

(Epsomite $MgSO_4 \cdot 7H_2O$).

According to an analysis undertaken by Rørdam (M. o. G. 8, 1889, p. 61) a salt collected on the plain within the northern arm of Söndre Strömfjord, the Sukkertoppen district, has the following composition: SO_3 22.06, Cl 2.60, CO_2 2.16, $Fe_2O_3 + Al_2O_3$ 4.00, MgO 13.88, Na_2O 9.59, K_2O 8.29, H_2O 37.05 = 99.63. The salt thus seems in the main to consist of hydrated magnesiumsulphate, but the analysis can hardly be correct, as the total amount of acid is merely sufficient to saturate the magnesium contents, whereas nothing is left for the other bases. This must, however, presuppose the presence of free bases or of basic salts, and this is hardly probable.

90. Pickeringite. $MgAl_2(SO_4)_4 \cdot 22H_2O$.

The Umanak district.

Akia on Storøen (GIESECKE 24-4-1811).

RINK: Monopolhandelen p. 94; Nrg. p. 46; Gr. I, p. 189.

The mineral which by GIESECKE is called "Haarsalz" is described as efflorescence, penetrating and partly covering heaps of clay formed from disintegrated rocks. The mineral consists of a loose aggregate of extremely fine fibres, the determination of which cannot be doubtful, as they have a refraction somewhat greater than ricinus oil, an oblique extinction with a maximum obliquity of 37° and are positive in the direction, which is most nearly parallel with the longitudinal direction. Analysis undertaken by CHR. WINTHER: SO_3 36.20, Al_2O_3 10.86, MgO 4.81, Na_2O 0.53, Li_2O 0.13, H_2O 47.47 = 100.00 (1.30 % of indissoluble constituents previously deduced.

91. Tschermigite. $NH_4Al(SO_4)_2 \cdot 12H_2O$.

The Umanak district.

Pujortoq at Niaqornat (ROSENKRANTZ 1938). Among the various sublimation products found in this locality also samples of t. have been collected. T. consists of quite loosely coherent aggregates of small crystals (up to 1 mm in diameter). The form can in certain cases be seen to be octahedral, but most of the crystals are strongly corroded and rounded. Analysis undertaken by WERNER CHRISTENSEN: $(NH_4)_2SO_4$ 21.4, $Al_2(SO_4)_3$ 55.2, $Fe_2(SO_4)_3$ 8.1, H_2O (below 110°) and various impurities 15.3. Besides a great amount of water of crystallization was found, which has not been accurately determined. The analysis thus agrees very well with t., which in a pure state requires: $(NH_4)_2SO_4$ 14.6, $Al_2(SO_4)_3$ 37.7, H_2O 47.7.

(Mirabilite $Na_2SO_4 \cdot 10H_2O$).

M. is mentioned by KRANZ (Fortsetzung der Historie von Grönland, 1770) as "Sal mirabile nativum" in elongated crystals, found in rocky caverns, which are washed over by the ocean. No locality is given, and the mineral is probably not accurately determined.

92. Gypsum. $CaSO_4 \cdot 2H_2O$.

The mineral is only found very scattered in West Greenland, whereas layers of gypsum are mentioned from several localities in the East-Greenland sedimentary formations. In the following, however, only a few samples of the latter will be described.

The Umanak district.

Akia on Storøen (GIESECKE 1811). Fibrous porous masses, white or brownish, mixed with clay, mica etc.

Kangilia (Rosenkrantz and Skou 1946). In shale above tuff from the upper Danian were found two spherical concretions consisting of limonite, probably formed by alteration of pyrite; the one of them has a diameter of 4 cm, and upon the surface there is a crust (c. 3 mm thick) of columnar gypsum. The other concretion, of which there only exists a fragment, seems to have had a diameter of about 2 dm; it is on the surface covered by a thin layer of gypsum crystals lying upon a face of (010) and of course turning the shining cleavage planes outwards; the diameter of the tables is c. 1 cm. In the same place were found very fine crystals, about 1 cm in length, grown in a cavity of a fossil lamellibranchiate; the crystals very pure with shining faces.

Angnertuneq (Rosenkrantz 1946). Here are found two very different forms of gypsum. The one consists of long (up to 5 cm) and thin crystals, bounded by the common faces and mostly twins, the faces being as a rule well developed. The other sample consists of a mass nearly totally formed of small (about 1 mm) crystals, rather loosely coherent and in some places of an almost sandy consistency; some calcite crystals are found in the gypsum. The colour is pure white, the crystal form the usual one.

Niaqornat (Rosenkrantz, Sole Munck, Troelsen 1938). The region round Niaqornat seems to be particularly rich in crystallized gypsum. It is only strange that these crystals have not been found earlier in this rather frequently visited place. At Niaqornat some clear, colourless crystals have been found in basalt-breccia; the length up to 6 cm, the faces the usual ones (010), (110) and (111), imperfectly developed and corroded. In Tunorssuaq, south of N. similar crystals, up to 9 cm in length from fissures. At Tuperssuartait west of N. large crystals (diameter up to 14 cm), somewhat skeletal and corroded, but otherwise with quite plane faces. The combination is the usual one, with twin formation along (100). At Pujortoq west of N. on the walls of fissures in basalt veins in the marine shales elongated, prismatic crystals (length up to 15 mm, width up to 3 mm); the faces rather well-developed and shining; a few twins.

The Godhavn district.

Tarajornitsoq (Steenstrup 1898).

Steenstrup: M. o. G. 24, 1900, p. 294.

Coating on pebbles in a small water-course originating from a spring about 100 m from the shore; the temperature in the spring 12°. The salt has been analyzed by Chr. Winther and forms coral-like, white branching formations of up to 3 cm in size. The name T. meaning "that which is not salt", is either owing to the fact that the fjord-water

is brackish in this place, on account of the great quantity of river water running into it, or also that the gypsum has no salt taste, even though in appearance it somewhat resembles salt.

The Egedesminde district.

Isuamiut (Porsild 1918). As efflorescence on black shale a very uneven and irregular crust of a brownish or yellowish colour. The gypsum crystals of which it is composed, are nearly microscopical.

The Sukkertoppen district.

Isortoq Fjord (Lytzen 1875). Small crystals (1—2 mm) as efflorescence on fine-grained gneiss. The faces are the usual ones, striated and rounded. The colour yellowish.

The Frederikshaab district.

The northern end of Igaussaq (Nyeboe 1915). Brown crusts about 5 mm thick, with a very uneven lumpy and warty surface. Under a microscope small prismatic crystal individuals are seen, divided by layers of limonite.

East-Greenland.

Liverpool Land (Rosenkrantz 1926—27).

Rosenkrantz: M. o. G. 110, No. 1, 1934, p. 27.

At a small river called Gipselv (ɔ: gypsum river) on the eastern side of Klitdalen (ɔ: valley in the downs) inside Hurry Inlet, samples of concretions or layers of gypsum have been found in grey shales. The gypsum is yellowish or greenish, more rarely reddish in colour and rather loosely coherent. The size of the grains up to 0.1 mm in diameter, but in a few cases also grey, larger individuals (up to 3 mm) are found. There are a number of impurities, in particular irregular enclosures of calcite and scattered, small crystals of anhydrite.

Ella Ø, southern coast (Chr. Poulsen 1929). In a black shale with yellowish-grey lime beds, dating from the youngest Precambrian, layers of a very pure whitish gypsum were found; the structure fine-grained.

West of Kap Franklin (Rosenkrantz 1929). Among the samples collected in this locality special mention should be made of the following two forms:

1. A fine alabaster-like mass, nearly pure white in colour. Under the microscope it proves to be a mixture of gypsum and anhydrite in almost equal quantities. In order to obtain a closer determination of the amounts of both minerals, the specific gravity was determined, being 2.56 (2.52—2.60). If the specific gravity of the gypsum is put

at 2.32, and that of the anhydrite at 2.96, the percentage of volume obtained for the composition is 37.5 or 43.4 weight percentage of anhydrite. The two minerals may be equally mixed or occur as more or less pronounced layers, which however are not macroscopically visible. The gypsum individuals generally are bounding to each other with very irregular boundaries.

2. A greyish, loose rock, resembling sandstone, the bedding planes along which it cleaves very easily, provided with a very regular relief (fig. 29) which reminds of ripple-marks and is perhaps also formed in



Fig. 29. Gypsum and dolomite. West of Kap Franklin. c. 1:2.

an analogous manner, but in much smaller dimensions than is otherwise common, the width of the single wave being only about 5 mm. The rock chiefly consists of gypsum, in which there are a number of dolomite crystals, partly found scattered and partly occurring as more or less continuous layers.

Kap Stosch (Alex. Jensen 1933). At River 13 east of this cape plate-shaped masses of fibrous gypsum have been collected. They are reported to lie under Lower Ophiceras Beds and above a hard sandstone; the thickness of the plates is 5—20 mm. The fibres may lie orientated normally to the plates, but also sometimes parallel with the level of the latter, in the shape of very thin fibres interchanging with the granular gypsum. The colour white, more rarely rosy. From Blaa Elv (ɔ: Blue River) east of K. Stosch, Wienberg Rasmussen in 1946 has collected crystals from a Cretaceous sandstone; the length is up to 7 cm. The form is the usual one; (010), (110) and (111) also twins on (100). The faces are very uneven, seemingly corroded.

Jørgen Brønlunds Fjord (Troelsen 1947). Found in a small crater as a sandy form or as a loosely coherent mass; the single indi-

viduals possess a dimension of nearly 1 mm; in the aggregate there is a tendency to a linear arrangement of the elements producing a striation in one direction. The substance is pure and white. The g. is accompanied with fibroferrite and copiapite.

93. Aluminite. $Al_2[(OH)_4SO_4] \cdot 7H_2O$.

The Umanak district.

Kangilia (Rosenkrantz 1946). Found as a filling out of fissures in shales from the Danian formation; only a few small samples are collected. The colour is light-yellow, the substance is rather loosely coherent.

Angnertuneq (Rosenkrantz 1946). Found in fissures in a Senonian shale; the a. is sometimes accompanied by small gypsum crystals. The colour is light brownish, the consistency rather loose. An analysis was undertaken by Werner Christensen with the following result: SO_3 23.0, Al_2O_3 27.9, Fe_2O_3 3.7, CaO 0.8, H_2O 41.5, Insol. 1.2 = 98.1. This composition corresponds rather well with that of the aluminite $SO_3Al_2O_39H_2O$, which requires SO_3 23.3, Al_2O_3 29.6, H_2O 47.1. The optical properties also correspond well with those of the a.

94. Fibroferrite. $\overset{III}{Fe}[OHSO_4] \cdot 4^1/_2H_2O$.

The Umanak district.

Akugdlît at Storø (Hertemerden 1938). Stalactitic and crusty material of a yellow colour; it seems rather impure, but far the greater part consists of f.; the silky lustre is not so immediately visible, as is the case with the other occurrences, but the determination is entirely certain.

Kûk (Rink). Yellow, silky masses mixed with impurities which cannot be determined in detail. The consistency is rather peculiar, somewhat horny with a shining streak The determination of the mineral is, however, entirely indubitable.

The Frederikshaab district.

Sermiligârssuk. At the southern arm of the glacier, in a cave about 5 m above sea-level samples of f. have been found and handed in to the Mineralogical Museum of Copenhagen by the Administration of Greenland. The colour is the usual yellowish grey, the consistency heterogeneous, sometimes hard and sometimes soft. The silky lustre not very pronounced on account of the many impurities, but under the microscope it is seen that most of it consists of the usual characteristic fibres.

East-Greenland.

Jørgen Brønlunds Fjord (TROELSEN 1947). Deposited in a small crater together with gypsum and copiapite; f. consists of small masses of loose consistency, it is finely fibrous and almost white; it is mixed with a large amount of loose limonite.

95. Copiapite. $MgFe^{III}_4[OH(SO_4)_3]_2 \cdot 18H_2O$.

East-Greenland.

Jørgen Brønlunds Fjord (TROELSEN 1947). In the above-named crater are found large masses of c., forming a loosely connected aggregate of quite irregularly formed elements. The colour is yellow, and the similarity with sulphur is very striking.

96. Wolframite. $(Mn,Fe)[WO_4]$.

The Frederikshaab district.

Frederikshaab (GIESECKE 1-6-1806). In the so-called "Raadne Fjelde" (ɔ: rotten rocks) which, according to more recent investigations, consist of diabase, GIESECKE on his first excursion in Greenland reports having found a small quantity of Wolfram. As this mineral, however, neither exists in the Copenhagen collections nor in those of Dublin, it is extremely doubtful whether it has really been found in this locality.

Ivigtut (GIESECKE 1809).

GIESECKE: Edinb. Phil. Journ. 6, 1821—22, p. 141. — Manual of Greenland, p. 341.

JOHNSTRUP: 12te Skand. Naturforskaremötets Förh. Stockholm 1880, p. 238.

Found in a single locality at the eastern end of the cryolite mass, as a rule not in the cryolite itself, but together with the transformation products of the latter, viz. thomsenolite and pachnolite; only in a single case the mineral has been found in pure cryolite, and then it must probably come from another part of the mine. Further w. is accompanied by the minerals generally occurring in the cryolite, such as quartz, siderite, galena etc. It is generally older than the accompanying minerals, for which reason the crystals are as a rule rather perfectly developed.

The crystals are elongated parallel with the b-axis, up to 8 cm in length. In appearance completely rhombic, and it is not possible by means of measuring to distinguish between the forms at the front and at the back. The following faces have been observed: *a* (100), *b* (010), *c* (001), *p* (610), *h* (310), *m* (110), *y* ($\bar{1}02$), *t* (102), *f* (011), *ω* (111), *o* ($\bar{1}11$), *Δ* (112), *e* ($\bar{1}12$) (fig. 30). They are very irregularly developed, and the

crystals are often quite fusiform, seeing that not only the prismal faces are strongly striated in a vertical direction, but also the faces (102) and ($\bar{1}02$) converge greatly towards the end of the crystal and are upon the whole so imperfectly developed that there is not a fairly plane faee on them. Towards the end of the crystal (001) which is rather plane is displaced by the two latter faces. The other faces are sometimes well developed, sometimes somewhat curved. Twins on (023) are very common; sometimes there is also a repeated twin formation. As the angle (023): ($0\bar{2}3$) is 60°6′ such a twin may form a regular six-rayed star. Owing to the imperfectly developed faces the slight deviation cannot be ob-

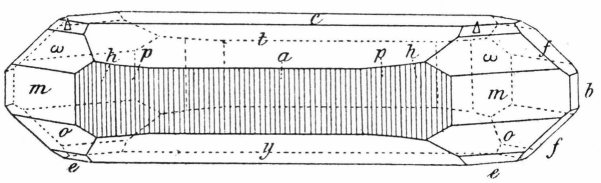


Fig. 30. Wolframite. Ivigtut.

served, nor is it possible to observe that the basal faces of the different individuals are not in exactly the same plane.

The specific gravity is determined at 7.334. The colour is black, and the streak brownish black; only the thinnest splinters are transparent under the microscope being of a deep red colour. Analysis undertaken by CHRISTENSEN: FeO 22.97, MnO 1.33, WO_3 75.19, Nb_2O_3 0.76[1]) = 100.25. The mineral occupies an external position in the wolframite-series, containing considerably smaller quantities of MnO than other occurrences of w.

The Julianehaab district.

Tunugdliarfik (RINK).

RINK: Gr. II, App. p. 149.

The crystal found by RINK and reported as being w., has, however, proved to be stenstrupine.

97. Wulfenite. $PbMoO_4$.

The Frederikshaab district.

Ivigtut.

GORDON: Acad. Sci. Philad. Notulae Naturae, No. 11, 1939.

From here there is a description of crystals of w. of a greyish yellow colour, nearly 1 mm long and found on thomsenolite. The following forms have been determined: (111), (221), (340) and (011); the measurings reported by GORDON agree very well with the values of w., but might also, to a certain extent, be in accordance with stoltzite.

[1]) produced as an undissolved residuum after being treated with Na_2CO_3; it has not been possible to test it further.

VII. PHOSPHATES AND ARSENATES

98. Monazite. $CePO_4$.

The Upernavik district.

Qeqertaq (Ussing 1886). Here only a single crystal was found of the size of about 4 mm. It occurred in pegmatite quartz, together with a few small tetragonal crystals which could not be accurately defined. The crystal is rather regularly developed with the combination: (100), (010), (110), (011), (111), ($\bar{1}01$), (001); the latter form is found at both ends of the crystal as quite small faces, probably produced by cleavage. This is all the more likely, as the crystal is everywhere penetrated by twin lamellæ with twin plane (001), which twin-formation is otherwise not known in the mineral, but perhaps produces the parting, frequently found in that direction. The lamellæ, it is true, are very thin but sharp and distinct, yielding good reflexes in the goniometer. The faces are well developed and shining, the colour dark-brown.

99. Apatite. $Ca_5[(F,Cl,OH)(PO_4)_3]$.

The ordinary forms are designated: $c = (0001)$, $m = (10\bar{1}0)$, $a = (11\bar{2}0)$ and $x = (10\bar{1}1)$.

The Thule district.

Between Kap York and Kap Alexander (Mylius-Erichsen 1903—04). A single cleavage fragment up to 4 cm in diameter; the colour greenish or grey.

The Umanak district.

Anoritôq (Rink).

Rink: Gr. I, 2, p. 215 (Nos. 212—13).

Crystallized in talc; the size of the crystals about 2—3 cm; forms m, x, c. The faces dull; the colour reddish white. Rink calls the mineral orthoclase, and he adds that these are the only good and distinct crystals of this mineral, which have been found in North-Greenland.

Storøen (Rink).

Rink: Gr. I, 2, p. 215 (No. 102).

Small crystals (about 1 mm) in great quantities in the disintegrated granite, the prism faces, *m* and *a*, nearly of the same size, shining; the ends of the crystals rounded. The colour vividly azure.

Ikerasak on Ũmánatsiaq (Giesecke 18-4-1811). Crystallized in mica schist together with quartz, hornblende and felspar. The size of the crystals up to 1 cm; only *m* and *a* developed; the colour green; semi-transparent.

Qaersut (Ravn 1909). Irregularly shaped grains (about 1 cm) in pegmatite from a vein in gneiss; the colour greenish.

The Godhavn district.

Ivnârssulik at Kronprinsens Ejland (Pjetursson 1897). Irregularly shaped, greenish grains (up to 1 cm) in pegmatite in mica schist.

The Christianshaab district.

Eqaluit, southern point of (Rink). Clear, light-green crystals (about 1 cm), together with felspar and biotite; the faces (*a* and *m*) imperfectly developed.

Kangerdluluk (Giesecke 3-9-1812). Small crystals (2—10 mm) in large-grained granite. Combination *m*, *a*, *x*, *c*, the two prisms on the smaller crystals equally well-developed. The faces often somewhat indistinct and curved. Rather clear and transparent; the colour light-blue or light-green.

Nûk (Rink). Crystallized (up to 15 mm) in quartz, brown asbestos and biotite, *m* the principal face, *a* very narrow, no terminal faces; rather clear of an impure, green colour.

Sarpiussat (Sylow 1883). Crystals (about 1 cm) with quartz, ilmenite and felspar; *m* without terminal faces; the faces rather shining; the colour reddish grey.

The Egedesminde district.

Ikamiut (Sylow 1883). Green grains (2—4 mm) in pegmatite consisting of quartz, oligoclase and biotite; no distinct crystal form.

Akugdlît (Giesecke 17-8-1812, Sylow 1883). Found as a fine-grained, light-blue aggregate in mica-schist, together with scapolite etc.

Sungaussaq (Giesecke 10-6-1808 and 16-8-1812).

Rink: Ngr. p. 44.

Rink: Gr. I, 2, p. 204.

Sylow: M. o. G. 8, 1889, p. 29.

This is by far the most considerable occurrence of a. in Greenland. It is found crystallized in large-grained mica-schist, partly also in granite. According to RINK the largest crystals attain up to 20 cm in diameter, but owing to their being so brittle it is impossible to loosen them; the largest crystals brought home attain a length of 10 cm. Combination *m*, *x* and *c*; the faces imperfectly developed, dull. The colour reddish and greenish grey. A large amount of a., however also occurs as irregularly shaped grains.

Inugsulik (RINK). Irregularly shaped individuals (up to 5 cm) together with quartz and orthoclase. The colour greenish.

Eqalugssuit (FÆSTER 1939). Crystals of up to 1 cm in length, found in labradorite and biotite. Form *m* and *a*, more rarely *x*; the colour greenish.

The Godthaab district.

Igdlorssuit (GIESECKE). Prismatic or irregularly shaped grains (up to 1 cm) in large-grained gneiss; the colour impurely bluish green.

Sadlen (ɔ: the saddle) (FÆSTER 1939). Small crystals (about 5 mm) in quartz, apparently forming lenticular masses in biotite schist. The crystals rounded without any distinct form. The colour bluish grey.

Qôrnoq Fjord, the neighbourhood of (SØRENSEN 1876). A single loose crystal (1 cm), rather regular and well-developed with short prisms (*m* and *c*); the colour greyish-green.

The Frederikshaab district.

Inugsuk Varde (ɔ: cairn) (GIESECKE 12-6-1808). Crystallized in large-grained gneiss; crystals (up to 1 cm) rather incompletely developed, only *m*. Clear bluish-green with pleocroism: ω bluish green, ε rather purely blue.

The Julianehaab district.

Niaqornârssuk (GIESECKE 2-9-1806). Found in fissures in nepheline-syenite together with ægirine and calcite, partly as a fine-grained or fibrous rather loose aggregate; partly as elongated crystals (*m* and *c*) sometimes nearly hair-shaped (length up to 20 mm, width up to 2 mm). The faces rather well-developed and shining; the colour faintly reddish or greenish.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 235.

FLINK: M. o. G. 24, 1901, p. 173.

Found in pegmatite veins, exclusively in the shape of small crystals, which belong to three different types, not immediately connected with each other.

1. (Yttriumapatite). Shape *m* and *c*; length and width about 1 mm. The crystals are generally fastened to the underlayer by faces of *m*; frequently several of them are found in a parallel position. The colour is enamel-white with a pronounced metallic lustre. The mineral is opaque. The specific gravity is 3.24. Analysis undertaken by MAUZELIUS: P_2O_5 41.12, F 3.59, CaO 47.67, Y_2O_3 etc. 3.36, Ce_2O_3 etc. 1.52, MgO 0.79, (Mn,Fe)O tr. H_2O 0.22, insol. 2.63 = 100.90 — O = F_2 1.51 = 99.39. Y has never before been found in apatite, Ce only a single time. This form of a. is found together with ægirine, epididymite, elpidite, neptunite, albite, synchysite, cordylite, polylithionite and other minerals. A. is one of the last-formed minerals.

2. Elongated, prismatic crystals, length 10, width 1 mm. Combination: *m*, *c* and sometimes *a*. The prisms are smooth and shining, the base uneven. Occurs as isolated crystals, which are completely colourless and clear, sometimes with a faint greenish tinge. The quantity was insufficient for an analysis, although it has been possible to identify a few rare earths. The mineral which was originally called "hexagonal prisms" occurs on ægirine together with zircon, violet fluorite, albite etc. A. is younger than the ægirine, older than the fluorite.

3. A very few small crystals (length and width 8 mm; shape: *m*, *a*, *c*, *x*, and *s* $(11\bar{2}1)$, *m* and *x* being the largest. The faces are well-developed. Colourless with a faint yellowish vinous tinge, nearly quite transparent. Specific gravity 3.175; the material insufficient for a chemical analysis. The mineral found together with previously formed elpidite; further, with felspar, ægirine, synchysite and other minerals.

The region of Kangerdluarssuk (FLINK 1897).
FLINK: M. o. G. 14, 1898, pp. 242 and 247.
GORDON: Proc. Acad. Nat. Sci. Philad. 1924, p. 265.

From Kangerdluarssuk itself FLINK mentions a great amount of presumably new minerals, viz. those designated 14 "Blekgult utan genomgångar" (ɔ: pale yellow without cleavage), 15. "Leukofanlikt" (ɔ: leucophanite-like), 16. "Hornblendeaktiga gula prismer" (ɔ: hornblende-like yellow prisms), 17. "Hornblendeaktiga hvita prismar" (ɔ: hornblende-like white prisms) all of them having been proved to be apatite. It is found crystallized together with arfvedsonite, ægirine, felspar, eudialyte, sodalite, nepheline and more particularly rinkite. A. is generally formed previously to the minerals in question, the rinkite sometimes being the first formed. The crystals are elongated prisms, *a* and *m* with *x* and sometimes *s* $(11\bar{2}1)$, the faces most frequently very well-developed. As a rule the crystals are white or greyish, frequently of a brown colour owing to an incipient disintegration of the rock; a few

crystals have a clear brownish or yellowish colour. GORDON mentions yellow crystals from the head of Kangerdluarssuk.

A. is also found in other parts of the Ilímaussaq batholite, the large nepheline-syenite area surrounding Kangerdluarssuk. At Nunarsuatsiaq the mineral is found which FLINK calls prehnite; it occurs in the shape of a greyish crust (about 2 mm) frequently consisting of regular layers of interchanging white and colourless material. Sometimes the crust is covered with small (1—2 mm) crystals in the shape of flat tables (*c* and *m*) with very regular faces. The exterior of the crystals is white and silvery, the interior clear and colourless. From this locality GORDON describes small, bluish aggregates with pseudomorphs of ægirine after arfvedsonite. From Igdlúnguaq the same author mentions aggregates of transparent brownish crystals, with natrolite in a vein in lujavrite.

Frederiksdal (Friedrichsthal) (EBERLIN 1885). Very closely packed crystals together with magnetite in syenite; somewhat curved prisms (1—2 cm) bounded by *m* with narrow faces of *a*; no terminal faces. The faces rather shining, the colour impure, dark greyish.

Qeqertaq, about 5.5 km west of Nanortalik (FÆSTER 1916). Small elongated (about 10 by 2 mm), greyish-green crystals in gneiss; the only distinct form is *m*.

East Greenland.

Dronning Louises Ø, eastern side of (EBERLIN 1884). Fragment of a crystal (15 mm); only prismal faces (*m* and *a*) developed about the same size. The colour dark-brown.

100. Britholite. $(Na,Ce,Ca)_5[F(SiO_4,PO_4)_3]$.

The Julianehaab district.

Naujakasik (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 245.

WINTHER: M. o. G. 24, 1901, p. 190.

BØGGILD: M. o. G. 47, 1911, p. 277. — Zts. Kryst. 50, 1912, p. 430.

HÄGELE and MACHATSCHKI: Zentralbl. Min. etc. 1939 A, p. 165.

Crystallizes hexagonally; the crystals chiefly bounded by $(10\bar{1}0)$ and $(10\bar{1}1)$ with narrow faces of $(11\bar{2}0)$ and exactly like apatite-crystals, though never with the base. Only in a few of the smaller crystals the faces are fairly regular and smooth, but otherwise the crystals are distinguished by a rather composite structure consisting of hypoparallel intergrown individuals. There is no cleavage, and the fracture is uneven. Hardness $5^1/_2$, specific gravity 4.446. Adamantine to vitreous. The colour is brown, the mineral is only transparent in thin flakes.

In polarized light b. shows great variation; some crystals or some areas are uniaxial, but others are biaxial with a rather small axial angle; the sign is at any rate negative. Refraction indices are recorded in Larsen's tables at: α 1.772, β 1.775, γ 1.777. Here one of the biaxial areas must have been used.

Before the blow-pipe b. is infusible; after being melted in an electric arc light and then cooled, the mass has a crystalline structure, uniaxial and negative, but with a considerably stronger birefringence than the original miniral (about 0.03 as against 0.004). It is striking how easily the mineral is dissolved by acids. Analysis undertaken by Chr. Christensen: SiO_2 16.77, P_2O_5 6.48, (Ce, La, Di)$_2O_3$ 60.54, Fe_2O_3 0.43, CaO 11.28, MgO 0.13, Na_2O 1.85, H_2O 1.27, F 1.33 = 100.08.

B. has only been found as crystals, which most frequently are fully developed, as it has crystallized before the other pegmatite minerals; only the ægirine sometimes penetrates into it. The crystals can be found in the various main constituents of the pegmatite, though mostly in arfvedsonite. They do not attain more than 1 cm in length, and the material is upon the whole very sparse.

Flink designates b. as a "cappelenite-like mineral"; Winther, who undertook the detailed description, named it after its great specific gravity; he regarded the mineral as rhombic, but the author has tried to prove that it is in reality hexagonal. Häbele and Machatschki have shown that b. not only outwardly bears a great resemblance to apatite, but that also the structure is quite analogous; they call the mineral "Cererden-Silikatapatit", and give its formula as analogous with that of the apatite viz. (Ca, Ce, Na)$_5$ ((Si, P)O_4)$_3$ (OH, F). If this formula is quadrupled and written as ($Na_2Ca_7Ce_{11}$) ((SiO_4)$_9$ (PO_4)$_2$) (OH, F)$_4$ it agrees very well with the above analysis.

B. has not been found outside Greenland.

101. Dahllite. Composition nearly as Apatite.

The Julianehaab district.

The region of Kangerdluarssuk.

Bøggild: M.o.G. 51, 1915, p. 437, and Zts. Kryst. 55, 1920, p. 417.

From various localities in the naujaite, samples of the rock have been collected with crusts of d. attached to it. The localities are partly Kangerdluarssuk itself, and partly Nunarssuatsiaq and Naujakasik at Tunugdliarfik Fjord. D. forms agat-like crusts, a few mm thick, and together with it natrolite always occurs, frequently in layers interchanging with those of the dahllite. Sometimes also quite small crystals of d. (up to 0.5 mm) occur, being bounded by prisms. An analysis of the agate-like mineral has been undertaken by Christensen:

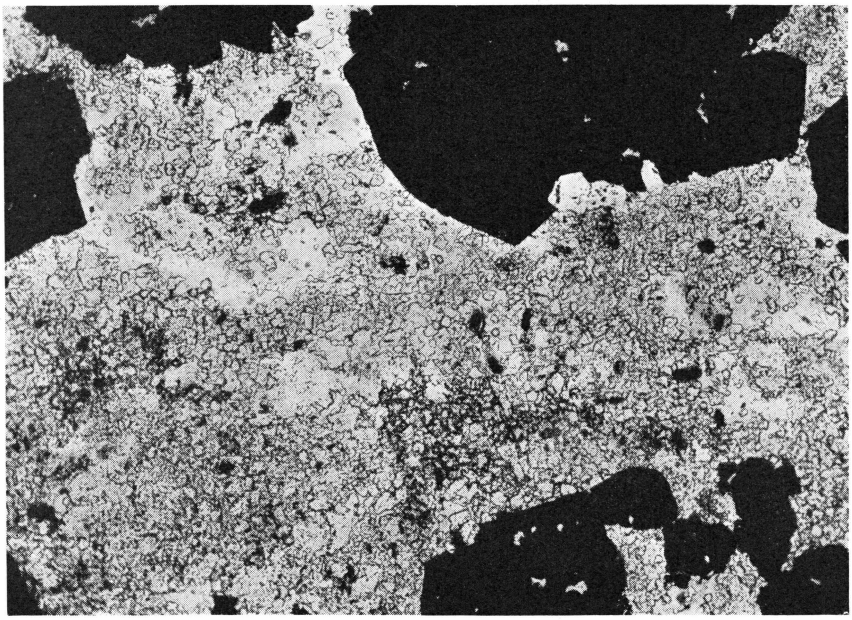


Fig. 31. Phosphorite with pyrite in quartz. Igaliko. c. 106:1.

P_2O_5 32.40, CaO 54.10, Al_2O_3 (determined as a remainder) 3.15, Na_2O 0.77, H_2O 1.32, CO_2 8.26 = 100.00 which agrees fairly well with the formula $Ca_3P_2O_8$, $CaCO_3$, but it can hardly be composed of a single substance, as the different physical conditions, more particularly the optical constants, vary greatly in different parts of the mineral. The only thing that can be said with certainty is, it seems, that the mineral represents a variety of the phosphorite group, which is unusually rich in calcium carbonate, and that the composition does not deviate very much from the original Norwegian dahllite.

102. Phosphorite. Composition nearly as Apatite.

The Julianehaab district.

Igaliko? As to this occurrence the reader is referred to what has been said above under pyrite and fluorite. P. partly occurs in a mixture of quartz with fluorite crystals, partly in a fine-grained quartz (fig. 31). P. occurs scattered in both of the minerals mentioned above, sometimes in rather small quantities, though mostly in such quantities as to constitute nearly half of the total mass. P. has the shape of small (0.01—0.03 mm) irregularly spherical masses; hardly any birefringence is to be observed.

East-Greenland.

Nathorst Fjeld (Rosenkrantz 1926).

Rosenkrantz: M. o. G. 110, 1, 1934, p. 84.

In a sandstone fossiliferous concretions are found, frequently transformed into p. The present material consists of a brown phosphorite mass, as a cement in sandstone.

(Pyromorphite. $Pb_5[Cl(PO_4)_3]$).

Tayler (Addenda to Giesecke's Catalogue of Minerals p. 215) reports having found a fragment of rolled phosphate of lead in gravel near Julianehaab. The occurrence of p. in Greenland can, however, hardly be regarded as certain, for there may partly be a possibility that the determination is incorrect, partly that it may originate from quite a different locality, as in all other cases where a mineral has only been found in a single specimen in Greenland.

(Scorodite. $\overset{III}{Fe}[AsO_4]\cdot 2H_2O$).

In Giesecke's Catalogue of Minerals, p. 207, s. is mentioned in a parenthetical remark, added by the editor to scorza from Qôrorssuaq in the Julianehaab district. The latter mineral, which is otherwise identical with epidote, is also recorded as such in Giesecke's Reise 2-9-1806, where mention is made of "ein grünliches, körniges, dem erdigen Epidot (Skorza) ähnliches mir unbekanntes Fossil mit basaltischem Grünstein und Gneiss". The occurrence of s. from this locality may, it seems, be regarded as very uncertain.

103. Vivianite. $\overset{II}{Fe}_3[PO_4]_2\cdot 8H_2O$.

This mineral is mentioned a couple of times from Greenland. Robert (Bull. Soc. Géol. de France, 12, 1841, p. 365) states that it was presented to him by Senator Binger of Hamburg, being contained in a fragment of a quartz- and iron-bearing conglomerate. The fragment is said to originate from Greenland, which, however, must be regarded as extremely uncertain, as nothing more is known of its occurrence. Rink (Gr. II, App. p. 152) records iron phosphate in asbestos from Arsuk, the Frederikshaab district. The mineral is expressly mentioned as originating from older records and therefore less certain; it may possibly have been mistaken for the crocidolite occurring in the same locality and in colour very much resembling v. This also applies to the fibrous iron-phosphate, which in Giesecke's Catalogue of Minerals p. 207 was mentioned from Qôrorssuaq, the Julianehaab district. Small amounts of v. has been found in the following places.

The Jakobshavn district.

Sermermiut at the Icefjord (Porsild 1917). Thin coatings of v. upon different objects (Gneiss, schist and an old knife blade). The colour is bluish grey.

The Egedesminde district.

Manîtsoq. A very thin bluish layer upon a fragment of granite.

The Godthaab district.

Qasigiánguit. Occurrence as the former one; both specimens originate from older collections.

104. Erythrine. $CO_3[AsO_4]_2 \cdot 8H_2O$ and
105. Annabergite. $Ni_3[AsO_4]_2 \cdot 2H_2O$.

The Thule district.

Port Foulke.

EMERSON: Amer. Geologist, 35, 1905, p. 94.

The minerals are recorded to occur together with blue spinel, dumortierite as well as sulphides of cobalt and nickel.

(Wavellite. $Al_3[(OH)_3(PO_4)_2] \cdot 5H_2O$).

This mineral is mentioned by GIESECKE (BREWSTER's The Edinburgh Encyclopædia, 1816) who states that "Wavellite (radiated siderite containing carbonate of lime and magnesia)" has been found at Kaniuaq in Umanak Fjord; here he is clearly thinking of the peculiar spherical masses of siderite, found in this locality. This report is quoted i. a. by LEONHARD Oryktognosie, 1821, p. 414 and RINK (Gr. II, p. 152), the parenthetic remark, added by GIESECKE, not being quoted by either author. Further GIESECKE records the mineral from Disko, however without specifying the locality. (Trans. R. Soc. Edinburgh, 1821, p. 9) where the general enumeration of the minerals of the island i. a. contains the following statement: "10. radiated and concentric globular mineral of a yellowish green colour which I take to be wavellite". The mineral in question is presumably prehnite, which is found on Disko in the form recorded.

VIII. SILICATES

105. Willemite. $Zn_2[SiO_4]$.

The Julianehaab district.

Musartut (Rink, Steenstrup).

Descloizeaux: Manuel de Minéralogie, 1, 1862, p. 554.

Lorenzen: M. o. G. 7, 1893, p. 14.

Crystallized in large-grained quartz in an altered eruptive dyke in sandstone. The crystals are 1—25 mm in size. The form generally short-prismatic; as a rule the length is equal to the width; sometimes twice as large. On most crystals there are no other faces than a $(11\bar{2}0)$ and l $(01\bar{1}2)$, but some of the smaller crystals abound in faces, as shown

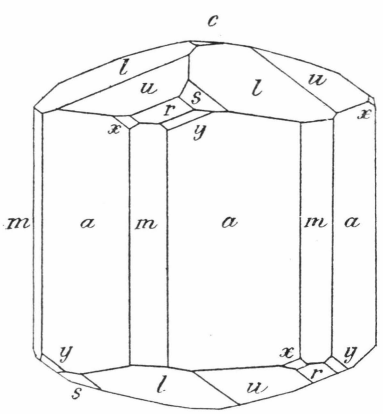


Fig. 32. Willemite. Mussartût.

on fig. 32 which, besides the faces mentioned, has m $(10\bar{1}0)$, u $(2\bar{1}\bar{1}3)$, s $(11\bar{2}3)$, r $(10\bar{1}1)$, x $(3\bar{1}\bar{2}1)$, y $(21\bar{3}1)$ and c (0001), the latter always very insignificant; a few other forms may also be found. The tetartohedrism is very little pronounced; it is essentially apparent by u being constantly greater than s, which may also be entirely lacking; x and y are equally developed.

The character of the faces differs very much; some of them, such as a, r, l and c are well developed, brillant and shining and therefore

yield very good reflexes; the remainder, on the other hand, are more or less uneven and dull, with irregular elevations and depressions.

The specific gravity is by STEENSTRUP (in LORENZEN) determined at 4.11. The colour is most frequently very pure and vividly light-blue; a few of the smaller crystals, especially those which are richest in faces, are a darker bluish grey. There is no pleochroism. The refraction is determined by means of a total reflectometer: ω 1.6928, ε 1.7234.

Analyses have been undertaken by DAMOUR (1, in DESCLOIZEAUX) and LORENZEN (2).

	1	2
SiO_2	27.86	26.01
ZnO	71.51	74.18
(Fe, Mn)O.....	0.37	0.41
insol.	—	0.10
	99.74	100.70

The usual formula of the mineral Zn_2SiO_4 requires SiO_2 27.0, ZnO 73.0.

107. Olivine. $(Mg,Fe)_2[SiO_4]$.

The Umanak district.

Qaersut (STEENSTRUP). Found almost pure in the shape of peridotite, in which the qaersutite is found imbedded in the shape of fissure fillings.

The Egedesminde district.

Eqalugssuit (KORNERUP 1879).

KORNERUP: M. o. G. 2, 1881, p. 155.

It has proved that most of the yellow grains, which were formerly looked upon as chondrodite are in reality olivine, and only a single one of the samples brought home by KORNERUP contains chondrodite. O. has the shape of irregularly formed small-sized grains (mostly a few mm) found in dolomite together with spinel and phlogopite; in certain parts entirely transformed to serpentine, and there are all sorts of transitions.

Nagssugtôq, Northern side of, about 20 km from the mouth (PJETURSSON 1897).

PJETURSSON: M. o. G. 14, 1898, p. 291.

In this locality small yellow grains are also found in dolomite, which have formerly been taken to be chondrodite; many of the grains are entirely or partially altered into serpentine.

The Holsteinsborg district.

Ungôriarfik (KORNERUP 1879).

KORNERUP: M. o. G. 2, 1881, p. 155.

The occurrence in every respect analogous with the two preceding ones.

The Sukkertoppen district.

Siorarssuit, west of Ikerasârssuk (Giesecke 11-7-1808).

J. A. D. Jensen: M. o. G. 8, 1889, p. 76.

Rørdam: M. o. G. 8, 1889, p. 123.

O. occurs as a fine-grained rock, which has largely crumbled to sand. The rock is yellowish green and very brittle; it contains a few foreign minerals such as green hornblende (grammatite), biotite and chromite. Seen under the microscope it proves to be traversed by numerous fine fissures, filled with darker-coloured serpentine. In a few parts it is more serpentinized. The specific gravity of the pure o. is 3.51, of the transformed 3.08. Analyses have been undertaken by Rørdam on the fresh (1) and on the serpentinized rock (2).

	1	2
SiO_2	39.17	43.81
Al_2O_3	3.30	3.29
FeO	10.56	10.31
MgO	43.46	38.13
NiO	tr.	tr.
CaO	tr.	tr.
$(K, Na)_2O$	0.55	0.13
H_2O	0.91	1.41
Foreign matter	1.59	2.37
	99.54	99.45

As the water contents of the serpentine should normally be about 13 %, the degree of transformation, even of the serpentinized o. must be very small.

Atangmik (Nyeboe 1915). A mass (about 4 cm in diameter) of slightly coherent olivine crystals together with talc. The boundary between both minerals is rather irregular, and it is possible to find small amounts of o. scattered in the talc, farther away from the main mass. Smaller quantities of chlorite accompanies both minerals; the individual olivine crystals are about 1 mm in diameter; they are so imperfectly developed that it is not possible to determine their shape. The colour is yellowish.

The Godthaab district.

Kapisilik.

Lappe: Pogg. Ann. 43, 1838, p. 669.

Reported to have been found as reddish-brown grains intergrown with magnetite and accompanying actinolite.

Ameralik.

LAPPE: Ibid.

Found together with green mica, actinolite and dolomite. Analysis: SiO_2 40.001, FeO 16.213, MgO 43.098, Al_2O_3 0.060, (Ni, Mn, Cu)O 0.549 = 99.921.

Qarajat (GIESECKE 1808).

GIESECKE: Catalogue of Minerals, p. 210.

Is reported to have been found as small grains mixed with mica.

Aunikasik at the northern side of Qarajat (FÆSTER 1944). From here originates a number of samples of a mineral mass of quite an unusual kind. It is all reported to be greatly decomposed and crumbled, but the samples collected are as a rule fresh and well coherent. The various mineral individuals are rather large (1 dm or more) but grown into each other in a very intricate manner, so that cleavages are seen everywhere, in innumerable cases broken off, but maintaining the same direction and thus reflecting like scattered spots. The mixture for the greater part seems to be olivine and enstatite, and besides asbestos-like anthophyllite occurs closely associated with the enstatite, phlogopite, chlorite, talc and magnesite. As veins in this mass may be found a mixture of oligoclase and hornblende, resembling pegmatite.

The olivine is generally found in close association with the enstatite, in such a manner that a large individual of the enstatite is penetrated by o., found as fine-grained (sizes of grains 1—3 mm) rather slightly coherent masses which, however, in sections prove to consist of rather large individuals, in all directions traversed by fissures. O. is also found nearly quite pure, only mixed with small quantities of phlogopite; it is of a very loose consistency, so that only by steeping it in gypsum it has been possible to find out its structure, which proved to be fine-grained. The colour of the olivine is impurely greenish yellow.

ALIARTOQ (GIESECKE 1808).

GIESECKE: Catalogue of Minerals, p. 210.

From this island which is not situated particularly far from the preceding locality mention is made of granulous o.

The Frederikshaab district.

Frederikshaabs Isblink (HOLST 1880).

TÖRNEBOHM: Geol. Fören. Förh. Stockholm, 6, 1883, p. 705.

Scattered as small (up to 2 mm) grains in grey melilite basalt. The grains are only in part shaped as crystals; they are colourless and completely fresh.

Tigssaluk (HOLST 1880).

TÖRNEBOHM: Ibid.

Found as grains (up to 2 mm) in an olivine proterobase; indistinct crystal form. The olivine when fresh is colourless and when decomposed passes into colourless serpentine, with grains of magnetite. Further o. is found as phenocrysts in a loose block of limburgite. The grains are for the greater part transformed to serpentine.

East-Greenland.

Qasigíssat at Angmagssalik (KNUTSEN 1885). Small grains (1—7 mm) in large-grained marble. The surface greatly rounded without a distinct crystal-form. Colourless, transparent, in decomposed parts dark, owing to serpentinization.

Grusgraven (ɔ: the gravel pit), 66°5′ N. (KRUUSE 1899).

O. NORDENSKJÖLD: M. o. G. 28, 1904, p. 7.

Irregular, colourless grains of fresh o. in a hornblende rock.

Gneiss Canon (ROSENKRANTZ 1926). Here layers of limestone have been found, very rich in small (about 1 mm) enclosures of rounded mineral grains; besides o. grains of scapolite and orthoclase are found. The grains rounded, colourless, the interior traversed by numerous fissures.

108. Chondrodite. $Mg_5[(OH,F)_2(SiO_4)_2]$.

The Egedesminde district.

Eqalugssuit (KORNERUP 1879).

KORNERUP: M. o. G. 2, 1881, p. 155.

Crystallized in dolomite together with mica and spinel. The size of the grains 1—5 mm. The faces shining, but greatly rounded so that the form is undefinable; the colour brownish, sometimes more yellow or red; strong pleochroism. Specific gravity 3.208.

East-Greenland.

Liverpool Land (O. NORDENSKJÖLD 1900).

NORDENSKJÖLD: M. o. G. 28, 1909, p. 283.

On the western side of Liverpool Land NORDENSKJÖLD has in various localities found layers of marble in the gneiss; the marble is always rich in small grains of foreign minerals, among others also chondrodite.

109. Andalusite. $Al_2[OSiO_4]$.

The Julianehaab district.

Nanortalik (EBERLIN 1884).

EBERLIN: M. o. G. 9, 1889, p. 254.

Found in rather small quantities in the white pegmatite veins in

the gneiss, also containing garnet, tourmaline and arsenopyrite. Crystallized (up to 4 cm) in quartz, microcline and smaller quantities of mica. No other faces than (110) are developed, generally rather incompletely. The colour reddish.

East-Greenland.

Dronning Louises Ø, eastern side of (EBERLIN 1884).

EBERLIN: M. o. G. 9, 1889, p. 254.

The occurrence nearly like the preceding one, though no arsenopyrite has been found in this and the following locality. The length of the crystals up to 8 cm. The only form is (110), sometimes with rather shining faces, but most frequently coated with small mica leaves. The colour reddish, with a more or less brownish tinge.

Nanûseq, island outside (EBERLIN 1884).

EBERLIN: M. o. G. 8, 1889, p. 254.

Occurrence as the preceding. The crystals up to 3 cm, very incompletely developed. Only (110) was found, coated with mica. The colour reddish.

110. Cyanite. $Al_2[OSiO_4]$.

The Christianshaab district.

Nûk (SYLOW 1883). Crystallized in a loose block of gneiss, together with staurolite. The crystals are very elongated (length up to 2 cm) incompletely developed, sometimes with (100), $(1\bar{1}0)$, (010). The faces very uneven. Strong parting in the direction of (001); the colour greyish, sometimes faintly bluish.

East-Greenland.

Danmarks Ø (BAY 1892).

BAY: M. o. G. 19, 1896, p. 154.

Found in rather large quantities in a dark mica schist. The appearance of the crystals very nearly as in the preceding occurrence.

111. Topaz. $Al_2[F_2SiO_4]$.

The Frederikshaab district.

Ivigtut (STEENSTRUP 1899).

STEENSTRUP: M. o. G. 34, 1910, p. 142.

BØGVAD: M. o. G. 92, 8, 1933.

BØGVAD: M. o. G. 119, 7, 1938, p. 5.

First mentioned by STEENSTRUP, who describes a single specimen of cryolite, containing small radiate-crystalline grains of a white colour

with great hardness and specific gravity 3.51. An analysis undertaken by Chr. Christensen yielded the following result: SiO_2 30.02, Al_2O_3 58.51, F 18.53 = 107.06 — O 7.80 = 99.26. This agrees very well with the usual composition of the topaz.

Further Steenstrup mentions other samples containing similar grains which, however, are soft and of a specific gravity of 2.83. The analysis points towards the substance being muscovite, which is thus presumably a pseudomorph after the topaz.

Since 1910 very large quantities of topaz-bearing samples have been sent in from Ivigtut, so that one rather gets the impression that this mineral is widely distributed in the cryolite massif. In appearance it bears very little resemblance to the ordinary forms of the mineral, and though it may occur at Ivigtut in a somewhat different manner, there is the common feature that the single crystal individuals are very small, entirely or nearly microscopical. It is in the main possible to distinguish between two different forms of the mineral, the spherulitic aggregates and the individual crystals.

1. The spherulitic forms. These absolutely constitute the principal mass of the occurrences; and also those which were first described by Steenstrup. The spherulites mostly occur in cryolite, where they sometimes may be found singly as spherical masses, at most 2 mm in diameter, which corresponds with the fact that the greatest length of the crystal individual is about 1 mm. The thickness of the crystals is extremely small and can hardly be measured; frequently there are a quantity of globules coalesced into more or less irregularly shaped masses; and from here there are transitions to larger, more or less pure aggregates of topaz (fig. 33). In small cavities in such aggregates well-developed crystals can be found, being up to 0.03 mm thick, which is the maximum of the occurrence. If the crystals are placed vertically in the section, the two usual prisms of the mineral are distinctly visible.

In other cases the spherulites become essentially smaller and at the same time also more irregular; thus aggregates are formed, which are essentially different in appearance from the ordinary ones. Instead of the finely gritted structure of the latter a quite massive aphanitic substance is formed, which is entirely like china in appearance.

The topaz-aggregates are, however, not only to be found in cryolite but also in other minerals, particularly in fluorite or in a mixture of fluorite and cryolite. In many cases the topaz is transformed into mica, which for that matter also occurs mixed with the fresh topaz.

A transition between the two forms of topaz is a quartzitic rock which, besides small quantities of cryolite, siderite and other minerals, contains great quantities of topaz, frequently found as star-shaped

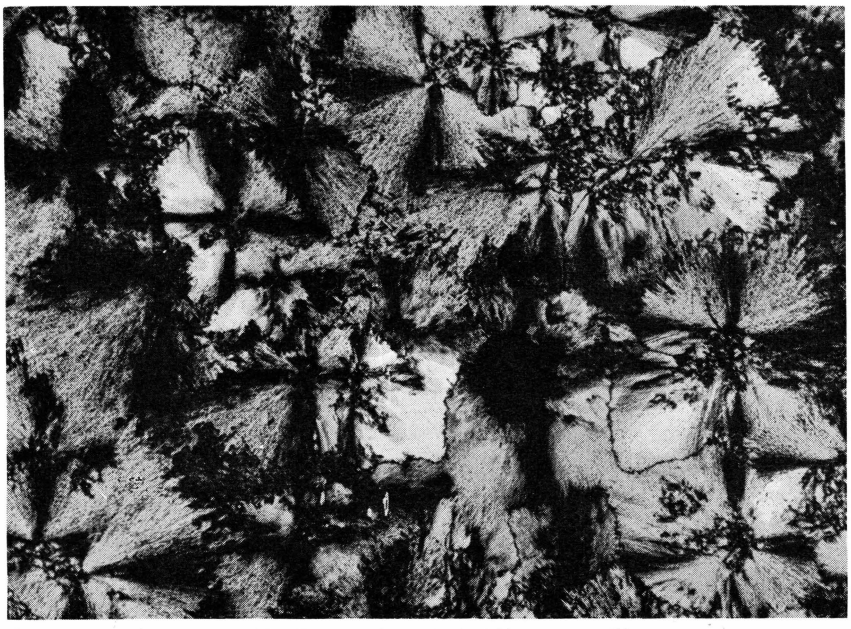


Fig. 33. Topaz. Ivigtut. Nic. +, c. 50:1.

crystal groups, but also in groups of quite few crystals or as individual crystals.

2. Occurrences of scattered topaz-crystals have only been found in a very few cases, in the shape of a white china-like cryolite, which by Bøgvad is called topaz-cryolite and contains large quantities of topaz-crystals arranged at random; if the pulverized material is put into water, nothing but the topaz is seen. The crystals seem to be well-developed, but are very small (length about 0.03, thickness about 0.01 mm). Also in fluorite and in metajarlite scattered topazes may be found.

In conclusion mention must be made of the peculiar columnar aggregate reported by Bøgvad (1933); in addition to topaz it contains thomsenolite, fluorite, barite and a new fluoride which has not yet been described in detail.

112. Staurolite. $Al_4[Fe^{II}O_2(OH)_2(SiO_4)_2]$.

The Jacobshavn district.

Without specified locality (Rink). Crystallized in mica schist; the size of the crystals 2 cm. Combination (110) and (010), no terminal faces. The faces dull, the colour dark-brown.

The Christianshaab district.

Nûk (Sylow 1883). Crystallized in a loose block of gneiss, together with cyanite and garnets; the crystals up to 3 cm, very imperfectly

developed; the faces frequently quite indistinct, sometimes with (110) and (010), and always very uneven. The colour dark-brown, pleochroism distinct: c brownish yellow, a and b pure yellow.

The Egedesminde district.

Isuamiut (O. R. B. Hansen). A fine-grained, light-coloured mica schist, in which there are a number of small staurolite crystals, being of the same size and shape as those from the following locality, but not so numerous.

Manîtsoq (Giesecke 13-9-1812).

Rink: Ngr. p. 41.

Crystallized in muscovite schist, together with biotite and actinolite; according to Rink the mineral is found in talc schist. The crystals (2 cm) are incompletely developed with (010) and (110). The faces very uneven and dull, the colour dark-brown, sometimes greyish brown.

Greenland without known locality.

Crystallized in light-coloured mica schist. The crystals (up to 6 cm) rather well developed with (001), (110) and (010) very narrow; sometimes cruciform twins with (232) as twin plane. The faces of 110 are most perfectly developed, as a rule plane and shining, (010) also fairly plane, but coated with a layer of mica: (001) is quite uneven. The colour black-brown: c is blood-red, a and b reddish or brownish yellow.

113. Sapphirine. $Mg_2Al_4[O_6SiO_4]$.

The Sukkertoppen district.

Sukkertoppen (Ramberg 1946). An occurrence of sapphirine was found in the island of S. A description of the petrography and the mineralogy of the place has been undertaken by Dr. Ramberg and published in M. o. G. 1948.

The Godthaab district.

Auvaitsersarfik (Giesecke 1-6-1810). Found in connection with gedrite, corundum, black spinel and a mica (phlogopite or biotite). The individuals of s. are rather small, only a few mm in length; the form is extremely irregular, chiefly, however, consisting of plates which are very variable in thickness, curved and contorted. They are very often situated at the boundaries of the other minerals, but they may also be seen in their interiors. In somewhat thicker plates the s. is almost black, but in thinner plates they are transparent with an intensive blue colour, and in thin sections of the ordinary thickness they only show a faint blue colour. The pleochroismus is very marked with the axes

b and c blue and the axis a yellowish brown (in the thin sections colourless).

Fiskenæsset (GIESECKE 5-9-1809).

STROMEYER: Göttingische gel. Anzeigen, 1819, p. 1998.

KOBELL: Grundz. Min. 1838, p. 235.

HAUSMANN: Mineralogie, 2, 1847, p. 427.

DAMOUR: Bull. Soc. Géol. de France, 6, 2. Ser. 1849, p. 315.

KOKSCHAROW: Materialien zur Mineralogie Russlands, 1, 1853, p. 214.

FORCHHAMMER: Pog. Ann. 91, 1854, p. 581.

DESCLOIZEAUX: Man. de Min. 1, 1862, p. 462 and 2, 1874, p. 42.

TSCHERMAK and SIPÖCZ: Zeits. f. Kryst. 3, 1879, p. 496.

LORENZEN: M. o. G. 7, 1893, p. 17.

SCHLUTTIG: Chemisch mineralogische Untersuchungen von weniger bekannten Silicaten. Diss. d. Univ. Leipzig, 1884.

MICHEL-LEVY and LACROIX: Les minéraux des roches, 1888, p. 277.

USSING: Öfvers. k. Vet.-Akad. Förh. Stockholm, 1889, Nr. 1. Zts. f. Kryst. 15, 1889, p. 598.

According to the information given by STEENSTRUP (in LORENZEN) s. is found in ellipsoidical interpositions in mica schist. The combination of minerals has been investigated in detail by USSING, according to whom a distinction may be made between the two different sapphirine-bearing rocks.

1. In addition to s. normally contains mica, gedrite and hornblende in varying quantities; of rarer occurrence also iolite, anorthite and kornerupine. S. is as a rule the oldest mineral, being found in tabular crystals, often in parallel intergrowth with mica. However, the circumstance that the marginal bounding is not complete points towards s. not being ready-formed at the time when the other minerals crystallized.

2. Contains s., bronzite and dark-green spinel, the main mass consisting of bronzite, constantly associated with s., whereas the spinel is found in a few parts; a light-brown mica is also found in very small quantities. Either all the constituents are irregularly shaped, or the bronzite alone has a crystal form; in all cases s. completely lacks the crystal form and is darker than the preceding variety.

The individuals are rather small (a few mm), mostly tabular parallel with (010); marginal faces are rare and the crystals composed of hypoparallel subindividuals. USSING has succeeded in finding (110) a. o. prisms, and furthermore (001) and (011). There is no cleavage, the fracture is uneven. The hardness is $7^1/_2$, the specific gravity is determined by USSING at 3.486. The colour and the pleochroismus are in common identical with those from the foregoing locality, but sometimes we find dark-green plates with the axial colours: a light greenish-blue, b dark bluish-green, c yellow, faded green. The optical properties have been

examined by Ussing: $\alpha = 1.7055$, $\beta = 1.7088$, $\gamma = 1.7112$, $2V = 68°49'$, the negative, acute bisectrix forms with the axis a an angle of 19° in the obtuse angle β, the axial plane is parallel with (010).

Analyses have been undertaken by Stromeyer (1), Damour (2), Lorenzen (3), Schluttig (4) and Ussing (5).

	1	2	3	4	5
SiO_2	14.3301	14.86	12.95	14.76	12.83
Al_2O_3	63.3036	63.25	64.44	63.23	65.29
Mn_2O_3	0.5209	—	—	—	—
Fe_2O_3	—	—	—	—	0.93
FeO	4.0092	1.99	1.66	1.65	0.65
MgO	16.9683	19.28	19.83	19.75	19.78
CaO	0.3755	—	—	—	—
Loss at ign.	0.4924	—	0.34	—	0.31
	100.00	99.38	99.22	99.39	99.79

The analyses 3 and 5 rather yield the formula $Al_{12}Mg_5Si_2O_{27}$, whereas the other three yield $Al_{10}Mg_4Si_2O_{23}$; the difference may, as proved by Ussing, easily be due to the presence of mica, which it is very difficult to separate from the sapphirine.

The mineral was found by Giesecke in 1809; he called it cyanite, on a later occasion emery, and in his catalogues written in German "blauer Diamantspath (saphirine)". Stromeyer who undertook the analyzing of the mineral did not change the name, although it had formerly been given to another mineral (hauynite). Stromeyer's analysis was entirely corroborated by Damour, but nevertheless there remained some doubt as to the independence of the mineral, and many supposed it to be an impure spinel. In the mineral Forchhammer found 2.45 % Fe_2O_3 and 1.75 % P_2O_5, for which reason he explained the blue colour as originating from phosphate of iron. Not until Lorenzen had undertaken his investigations, the independence of the mineral was universally recognized. The first crystallographic and optical investigations were undertaken by Descloizeaux; Tschermak and Sipöcz classed the mineral with the clintonite group, as in opposition to Descloizeaux they supposed the crystals to be flattened along the base. Not until Ussing had undertaken his investigations, all the various properties of the mineral were made entirely clear.

Outside Greenland the mineral in later years is known from Canada, Madagascar, India and West-Australia.

114. Garnet. $\overset{II}{R}_3\overset{III}{R}_2[SiO_4]_3$ $\overset{II}{R}$ = *Mg,Fe,Mn,Ca* $\overset{III}{R}$ = *Al,Fe.*

Garnet is very widely distributed in the pre-cambrian area of Greenland. It is generally red in colour (common g. or almandine), and only in the Juliane-

haab district a green or a brown g. occurs as contact formations in connection with more recent eruptives. By far the most common forms are *d* (110), *n* (211) and *s* (321). In the following a limited selection of the occurrences is mentioned.

In this connection there may be reason to mention two analyses of garnet from Greenland (the locality not specified). No. 1 is made by PFAFF (SCHWEIGGER'S Journ. f. Chemie, 21, 1817, p. 236); the garnet is mentioned as blood-red "schaliger Pyrop", specific gravity 3.634. No. 2 has been analyzed by KARSTEN (KARSTENS Archiv f. Min. und Geogn. 4, 1832, p. 389), and it is described as a precious red garnet. The latter may perhaps be the one mentioned below from Storø, the former cannot be identified with any known occurrence.

	1	2
SiO_2	41.82	39.85
Al_2O_3	17.82	20.60
FeO	32.42	24.85
MnO	3.12	0.45
CaO	0.80	3.51
MgO	4.90	9.93
	100.88	99.19

The Thule district.

Polaris Bay.

BESSELS: Bull. Soc. géogr. Paris, 1875, p. 248.

FIELDEN: Geol. Mag. New Ser. 2, 1895, p. 378.

Large garnet crystals were found in loose blocks, from which BESSELS concluded that they must have come from Ikátoq in the Godthaab district with the floating ice, the direction of the latter thus being entirely different from what it is now. However, FIELDEN demonstrates that this cannot possibly be the case, as the blocks have been found far above the marine boundary, for which reason they must thus originate from some neighbouring locality.

Port Foulke.

EMERSON: Amer. Geologist, 35, 1905, p. 94.

Icositetrahedric crystals (1—4 cm) together with red orthoclase. G. forms a shell round a mass consisting of quartz and bronze-coloured mica, which is partly decomposed to black-brown chlorite.

Wilcox Head (RYDER 1887). Fragments of large crystal individuals (up to 8 cm), nearly unaccompanied by other minerals. The colour red.

The Upernavik district.

Arfitsiaq (GIESECKE 19-7-1807). Found in a pegmatite vein in gneiss as irregularly shaped individuals, together with quartz and microcline; sometimes these minerals are grown into the garnet in the manner of graphic granite. The garnet is impurely dark-red, rather opaque.

Langø (Rink).

Rink: Gr. 1, p. 217.

Found together with quartz, orthoclase, iolite and graphite in veins in gneiss, as a rule irregularly shaped; sometimes crystals are found with rounded faces of *d* and *n*. Sometimes faintly reddish, opaque, sometimes clear with a deep-red colour.

The Umanak district.

Sarfarssuit at Itsako, Svartenhuk (Peter Davidsen 1947). Some crystals collected from crumbled gneiss. The size of the crystals 2—5 cm; form *d* with narrow faces of *n*. Some of the crystals are well developed with rather shining faces; the colour is dark-reddish.

Akia on Storø (Giesecke 24-4-1811).

Leonhard: Hdb. d. Oryktognosie, 1821, p. 428 ("Insel Akudlerne oder Runde Oe").

Rink: Ngr. p. 40.

Occurs in very large quantities in gneiss and mica-schist, frequently together with graphite, but also often in segregations of quartz; the most rounded grains only in part with developed faces, *d*, *n*, and more rarely *s*; there are also larger, irregularly shaped, as a rule crushed masses. Owing to the strong decomposition of the rock, there are numerous loose-lying specimens. The specific gravity is 4.06; the garnet is as a rule clear and transparent, deeply red, so that it would be possible to use the larger specimens for ornaments.

The Godhavn district.

Avdlâgîssat in Disko Fjord (Isak Danielsen). Crystallized in biotite schist; the crystals (0.5—2 cm) bounded by *d* with narrow faces of *n*. The faces most frequently well developed, the colour dark-red.

The Christianshaab district.

Nûk (Rink).

Sylow: M. o. G. 8, 1889, p. 27.

Found in very large quantities together with graphite in mica-schist as reddish or brownish crystals (up to 3 cm), comb. *d* and *n* with rather imperfectly developed faces.

The Egedesminde district.

Eqûtit (Steenstrup 1872). Closely packed crystals (about 1 cm) together with quartz; the crystals issue from a fissure and grow into the mica. Faces (*d* and *n*) are only found on the side bounded with mica. The faces regular and shining; the colour dark-red.

Manîtsoq (Giesecke 26-8 and 13-9-1812). Crystallized in dark mica schist together with staurolite and hornblende. Size up to 3 cm; combination *d* and *n*. The faces strongly curved, dull; the colour dark-red, rather impure.

Qâqarssuit (Sørensen 1900). Crystallized (0.5—1 cm) with hornblende in mica schist. Form *d* with well-developed, rather shining faces. The colour in the smaller crystals clear brownish-red, in the larger nearly black.

The Holsteinsborg district.

Qôrortussoq (S. Hansen 1888). From this locality a single larger fragment (about 340 gr), without any surrounding rock; the label states that it is bought at Q., but possibly originating from somewhere else e. g. from Auvaitsersarfik, a few, very strong translation faces in the direction of *d* make that origin probable.

Ũmânârssuk (Giesecke 27-6-1808). Here green garnet (aplome) is mentioned together with magnetite and iridescent felspar in granite; it may perhaps be somewhat doubtful, whether the determination is correct.

South Ström Fiord.

Trainer: Rocks and minerals, 22, 1947, p. 813.

At the inner end of the fiord, near the American naval camp the commander Sinkankas collected a boulder consisting of muscovite schist with garnets as large as currants. The examination has proved that they belong to a variety, rhodolite, being a mixture of two parts of pyrope and one part of almandine. The refractive index is found to be 1.76; the colour is described as a delicate shade of pale rose-red and purple.

The Godthaab district.

Nûgârssuk (Giesecke 5-8-1808). Crystallized (up to 4 cm) in gneiss; *d*, but the faces greatly disturbed by the crushing of the crystals; enclosures of quartz and biotite. The colour red.

Naujánguit (Giesecke 1808). Crystallized (up to 15 mm) in pegmatite, consisting of quartz and hornblende. *d* and *n* almost equally developed. The faces rather incomplete, dull and striated; the colour red.

Qârusuk (Fæster 1944) (fig. 34). The occurrence is by far the most characteristic of all the Greenland occurrences. According to the information given by the finder, the rock in question constitutes a smaller area (a few metres) in the beach immediately near the old dwelling place. The rock in which the garnets are found is fine-grained

(size of the grains about 1—2 mm) of a grey colour, and must rather be regarded as an amphibolite, even though the quantity of hornblende is rather small. The composition is simple; the principal constituent is labradorite of a white colour, and to this must then be added the hornblende, which is of the usual kind with strong pleochroism and smaller quantities of magnetite and apatite. Close to the boundary towards the garnets the hornblende and the magnetite disappear, and there is a zone of almost pure labradorite, about 5 mm thick; it is these white rings, in fig. 34 seen to divide the grey rock from the dark-red

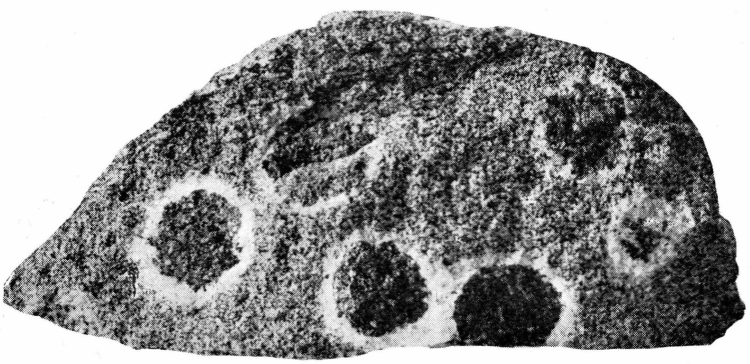


Fig. 34. Garnet. Qârusuk. c. 1:3.

garnet substance, which makes the occurrence particularly striking. However, the boundary of the white zone in either direction is very irregular in details, and the white mass rather gradually merges into both sides. Neither in the grey nor in the white mass are there any garnets.

The maximum diameter of the garnet crystals is about 4 cm. Owing to the above-mentioned irregular boundary towards the labradorite, it is impossible to isolate the crystal, and there can be no question of any external crystal form, but the greater part of the crystals are spherical. In sections it proves that they contain a great quantity of labradorite and also smaller quantities of hornblende. The garnet is everywhere penetrated with fissures, but that every sphere consists of one crystal individual appears distinctly, when it is held in direct sunlight; then all the small areas of the crystals will be seen to throw back the light in quite definite directions, which on closer investigation prove to correspond with the dodecahedral faces.

Qeqertánguaq (Giesecke 20-9-1808). According to Giesecke found in mica schist; in the samples brought home g. occurs as small (2—4 mm) very closely packed crystals (*d* and *n*) in white granulite. The faces greatly curved, the colour impurely red.

Ameralik.

LEONHARD: Handwörterbuch d. topogr. Mineralogie, 1843, p. 249.

LEONHARD mentions that large crystals with felspar, mica and sodalite are to be found at Ameragdlik; even apart from the latter mineral, which is not known in this region in Greenland, the description does not agree with any of the two preceding localities, both situated in Ameralik Fjord.

Auvaitsersarfik (GIESECKE 1-6-1810).

ABILDGAARD: Nat. Selsk. Skr. 2, 1792, p. 127.

SCHUMACHER: Ibid. 4, 1798, p. 225.

SCHUMACHER: Versuch eines Verzeichnisses der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 75.

GIESECKE: 1-6-1801.

LEONHARD: Handwörterbuch d. top. Mineralogie, 1843, p. 249.

A garnet, probably originating from this locality, was already before the days of GIESECKE collected by the Greenlanders, and consequently they were found in many collections, though GIESECKE was the first to demonstrate the locality. The rocks are gneiss, mica schist and hornblende schist, all containing g., which often occurs together with a peculiar iridescent anthophyllite or gedrite. The garnet has often a strong parting parallel with *d*, and on these faces it is generally coated with light mica, and it is often in the manner of graphic granite intergrown with small, white grains of labradorite. According to GIESECKE it may occur in lumps of more than 25 kg, and according to ABILDGAARD it has been used for ornamental purposes, and has yielded polished samples of more than 3 cm in diameter and entirely clear. The specific gravity is determined at 3.865 (SCHUMACHER) and 3.840 (BØGGILD), which values are uncommonly small for an almandine.

To this locality must possibly also be referred the two very much disputed analyses undertaken by TROMMSDORFF (Crell's chem. Ann. 1, 1801, p. 433) and GRUNER (GILBERT's Ann. d. Physik, 13, 1803, p. 491); they are said to originate from Greenland, and GRUNER expressly states that the mineral is garnet; in both analyses there are, however, considerable contents of zirconoxide which have caused them generally to be referred to eudialyte, until RAMMELSBERG (Sitzber. d. preuss. Akad. d. Wiss. Berlin, 1886, p. 441) called attention to the fact that the analytical methods for the determination of zircon at that time were extremely uncertain; besides, both the analyses contain a considerable amount of aluminum oxide, which agrees very badly with eudialyte. The mineral is described as very hard, which however does not agree with eudialyte; the specific gravity is by GRUNER found to be 3.827, which is very far from that of eudialyte (c. 3), but agrees very well with the values given above for the garnet. GRUNER also mentions the cleavage

planes coated with mica, and so it seems highly probable that the analyses have been undertaken on g. from Auvaitsersarfik.

Narssaq (GIESECKE 15-9-1808 and 26-5-1810). Found in veins in gneiss and mica schist; GIESECKE mentions the following mineral combinations: g. with epidote, salite, scapolite, quartz and calcite; with hornblende and with quartz, salite and pyrite. Most frequently irregularly, formed grains, sometimes also crystals (about 1 cm) with *d*, *n* and *s*; the colour dark-red.

KOLINGUAQ (RINK). Crystallized together with epidote, the interstices being filled with granulous calcite; most frequently greatly corroded and perforated. However, there are sometimes rather large (up to 4 cm) and well-developed crystals with *d* and sometimes small faces of *n* and *s*. The colour rather clear, dark red, the outer parts frequently altered into epidote.

LEONHARD (Handb. d. topogr. Mineralogie, 1843, p. 249) mentions g. from an occurrence "Kolkumak", which name may perhaps remind of Kolinguaq, but it is said that the garnet occurs in chlorite, and the locality was hardly known before the time of RINK's stay. LEONHARD also mentions an occurrence "Kulla", presumably the Finnish locality of that name, which by a mistake has been referred to Greenland.

Fiskenæsset (GIESECKE). Small crystals (1—5 mm) together with coccolite in quartz. d with very much rounded edges; the colour dark brownish-red.

From the same locality (1857) originate a few larger crystals (up to 4 cm) with muscovite attached to them. *d* with narrow faces of *n*; the faces imperfectly developed, the colour varying from a vivid red to dark-red.

Finally STEENSTRUP has brought home a sample from the southern side of the harbour opposite to the finding place of the sapphirine; in many respects it reminds of the occurrence at Qárusuk, but without the striking regularity of the latter. The rock is also here an amphibolite, consisting of labradorite and hornblende, but containing parts, where the two minerals occur as separate, rather irregular layers, and in such a rather thick white layer the garnets are found. They are rounded, about 3 cm in diameter and penetrated by labradorite almost in the same quantities as the actual garnet.

Ikátoq (GIESECKE 25-5-1809).

LEONHARD: Hdb. d. Oryktognosie, 1821, p. 428, and Handwörterbuch d. top. Mineralogie 1843, p. 249 and 243.

FORCHHAMMER: Oversigt Vid. Selsk. Forh. 1835—36, p. 22.

This occurrence is peculiar on account of its large and regular crystals, which are found in unusually great quantities. The rock is a

chlorite schist. The crystals are generally 2—3 cm, but many attain a size of about 1 dm. Form d with more or less shining faces, which are generally markedly filled with mica. The colour impurely dark-red or brownish-red. Analysis by FORCHHAMMER: SiO_2 40.35, Al_2O_3 18.21, Fe_2O_3 11.67, Mn_2O_3 1.91, FeO 18.31, MgO 9.11, CaO 0.22, K_2O 0.89 = 100.67.

LEONHARD mentions red garnet from Karkseutsiak, which is surely identical with Qeqertarsuatsiaq (= Fiskenæsset); further, red g. from Ikertok and brown g. from Ikartok, which localities are undoubtedly both identical with Ikátoq.

The Julianehaab district.

Josva's Copper-mine (RINK).

RINK: Gr. II, p. 147.

Small (up to 4 mm) yellowish or brownish clear crystals, together with epidote and bornite. Form *d*.

Ilímaussaq, southern side of (BØGGILD 1900). Small, clear greenish-brown crystals (1—5 mm) together with bornite, chalcocite and albite in altered diabase; form *d* with regular, but somewhat curved and dull faces.

Ipiutaq (BØGVAD). Small (up to 3 mm) crystals in a rock consisting of epidote, actinolite and plagioclase. Form *d*, very incompletely developed. The colour light-yellowish or dark yellowish-brown.

South Siorarssuit (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 244.

BØGGILD: M. o. G. 25, 1902, pp. 49 and 71.

Small (1—2 mm) clear, green crystals together with albite, ilvaite and epidote in altered nepheline-syenite. *d* with well developed faces.

Lichtenau (GIESECKE 20-7-1806). Particularly closely packed small (2—5 mm) crystals in greyish granulite. The shape indistinct, rounded, most nearly *d*; the colour reddish.

Siorartussoq at Kap Egede (FÆSTER). Grains (up to 2.5 cm) in biotite schist; the form quite irregular, the colour red.

Nanortalik (GIESECKE 6-8-1806). Crystals (up to 5 cm) in pegmatite together with tourmaline. *n* with small faces of *d*. The faces imperfectly developed, the colour dark-red.

East-Greenland.

Qipingajak (GIESECKE 1806). Crystals (2—4 cm) in biotite schist. Form *d* with rather well-developed faces. The colour impurely dark-red with a strongly bluish tinge.

Kangerajuk (SYLOW 1881). Crystals (1—3 cm) in gneiss; often penetrated with fissures and intergrown with quartz. Form *d*, *n* and *s*; the faces irregularly developed, striated and dull. The colour impure, reddish or brownish.

Nagtoralik, north of the mouth of (EBERLIN 1885). Crystals (2—20 mm) in pegmatite in gneiss together with tourmaline. *n* with very small faces of *d*. The faces irregular, curved and dull. The colour dark brownish-red.

Sarqap nûa (EBERLIN 1884). Crystals (1—2 cm) in a vein in gneiss. *n* with uneven, dull faces. The interior of the crystals penetrated by the constituents of the rock. The colour impure, dark-red.

Anâva (KRUUSE 1899).

O. NORDENSKJÖLD: M. o. G. 28, 1909, p. 9.

Pegmatite which according to KRUUSE's labels is reported to be found in granite, whereas the only sample found together with the pegmatite was an amphibolite. The pegmatite consists, in addition to mica, of a mixture of quartz and garnet, which has coalesced into a columnar aggregate, greatly resembling graphic granite; in thin sections it proves, however, that the various quartz columnæ do not belong to the same individual, but as to the garnet it seems to occur in sometimes rather large individuals (several cm in diameter), for when holding the samples in direct sunlight it is possible to see the same parting planes reflecting the light over large areas through many columnæ. Of other minerals there are in some of the samples large tabulæ of muscovite.

Runde Fjeld (HARTZ 1892).

BAY: M. o. G. 19, 1896, p. 156.

To be found crystallized in gneiss; the largest crystals (about 8 cm) were found on the top of the mountain. Form *d* with narrow faces of *n*; the faces very uneven. Strong parting along *d*. The colour dark-red.

Payers Tinde in Franz Josephs Fjord (1870).

Die 2-te Deutsche Nordpolfahrt, 2, 1874, p. 482.

Almandine (5—8 cm) crystallized in gneiss.

115. Epidote. $Ca_2(Al,\overset{III}{Fe})_3[OH(SiO_4)_3]$.

E. is very widely distributed in Greenland, but there are no particularly striking occurrences with larger crystals. In the following a limited selection of localities is given. The designation of the most important faces are: *a* (100), *b* (010), *c* (001), *e* (101), *h* (201), *f* (103), *i* ($\bar{1}02$), *r* ($\bar{1}01$), *s* ($\bar{3}02$), *l* ($\bar{2}01$), *m* (110), *u* (210), *o* (011) *n* (111) and *q* (221).

The Umanak district.

Ũmánatsiaq (Giesecke 1811). Crystallized in pegmatite; the size 1—3 cm. The smaller crystals clear, transparent, yellowish-green with shining faces (*a*, *c*, *r*, *n*), the larger ones dark-green or black with dull, very indistinct faces.

The Godhavn district.

The Biological Station (L. Geisler). Fine-grained together with quartz and felspar; in cavities crystals, most of which are small (1—2 mm) and only a single one 1 cm. Combination: c, a, e, i, m, o, n.

Fortunebay (O. R. B. Hansen). Small crystals, up to 5 mm, found in a felt-like asbestos mass. Bounded by *c*, *a*, *e*, and *i*, at the ends only *n*.

The Christianshaab district.

Isua (Giesecke 1-10-1807). Fine-grained mass with small (1—2 mm) crystals in cavities; the interstices between the crystals filled with calcite. Form square tables parallel with *a*; besides *b*, *u*, *c*, *e*, *r*,

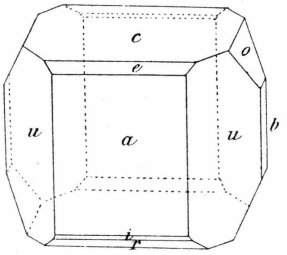


Fig. 35. Epidote. Isua.

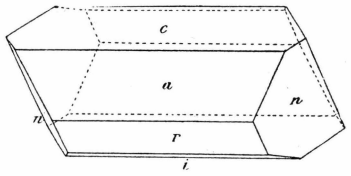


Fig. 36. Epidote. Nûk.

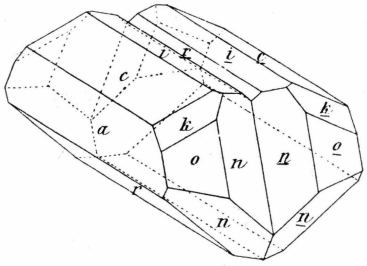


Fig. 37. Epidote, twin crystal. Nûk.

l, *o*, as appears from fig. 35 (where *l* has erroneously been named *i*). The crystals most frequently well-developed with sharp edges; the faces rather shining, sometimes somewhat curved.

Nûk (Rink). Granular crystalline together with large-grained quartz; in the latter numerous crystals (1—3 mm) are found, chiefly

bounded by *e*, *a*, *r*, and *n*. (fig. 36), sometimes also *o* and *k* and sometimes twins with a twin plane (100) (fig. 37). The faces rather imperfectly developed, dull and curved, the colour impure, dark yellowish-green.

The Godthaab district.

Kapisilik. Fragment of a single, unusually large crystal (length 12 cm, width 6 cm) without any surrounding rock. Form: *a*, *e*, *r*, and *n*; the faces, particularly of *c*, very level and shining, yielding complete reflexes, sometimes however more dull. The colour brownish- and greenish-black; clear and transparent with pleochroism: a greenish-

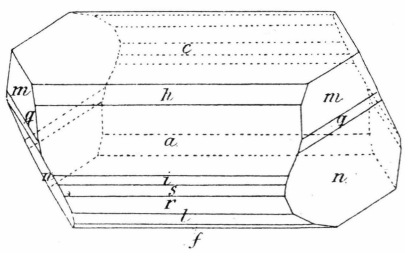


Fig. 38. Epidote. Nârssaq.

yellow, b dark-brownish, c greenish. As this crystal is quite unique in size and appearance among the Greenland epidotes, and as there are no other specimens of e. from this locality, there is a possibility that the crystal may come from quite a different locality and possibly is not even of Greenland origin.

Narssaq (Giesecke 14-9-1808). Crystallized in a vein in gneiss together with quartz, diopside and hornblende. The crystals partly enclosed in the other minerals, especially in the quartz, partly projecting in cavities. The latter are partly (originally perhaps completely) filled with calcite. The crystals vary in size from 1 mm to 5 cm. The combination most frequently like fig. 36, sometimes with a greater abundance of faces: *a*, *h* *c*, i^1), *s*, *r*, l^1), *f*, *n*, *q* and *m*. (fig. 38). The faces sometimes well-developed, sometimes indistinct and curved. The colour impurely yellowish-green.

Kolinguaq (Rink). Crystallized together with garnet; the cavities filled with calcite. The size 1—2 cm, the form very indistinct; the faces curved, etched and perforated, the colour yellowish-green.

The Frederikshaab district.

Kvane Fjord. Prismatic crystals of about 1 cm in length, partly also columnar aggregates enclosed in granular albite together with

[1]) On fig. 38 *l* and *i* have been exchanged by mistake.

chalcopyrite. Forms *a*, *e*, *c* and *r*. without terminal faces. The faces rather glossy and shining, the colour light yellowish-green.

The Julianehaab district.

Josva's Copper Mine (Rink). Small (1—3 mm) crystals together with grossularite and bornite in cavities in schist as crystals, rather incompletely developed, frequently without terminal faces; *a*, *c*, and *r* most common, rarely *n*; the faces glossy and shining; the colour yellowish-green.

Narssaq (Steenstrup 1888). Small crystals (about 5 mm) in cavities in a pegmatite vein in essexite. Combination *a*, *c*, *r*, *m* etc.

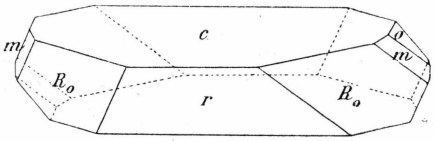


Fig. 39. Epidote. North Siorarssuit.

At the ends exclusively *b*, which is rather rare. The faces irregular, strongly striated. The colour light yellowish-brown.

North Siorarssuit (Flink 1897).

Flink: M. o. G. 14, 1898, p. 247.

In loose blocks of diabase porphyrite cavities are found with numerous small (1—2 mm) crystals, together with a few colourless octahedrons of fluorite. Combination *c* and *r*, with *m* and *o* and the very rare face R_0 (413) (fig. 39). The faces shining, but generally curved; the crystals clear, transparent and of a strong yellowish-green colour.

Narssârssuk (Lytzen's collection, 1893).

Flink: Geol. Fören. Förh. Stockholm, 1893, p. 208.

Found in pegmatite in the shape of fine-grained or microcrystalline masses of a yellowish-green colour. In very small cavities crystals of an apparently ordinary combination are found.

South Siorarssuit (Flink 1897).

Flink: M. o. G. 14, 1898, p. 244.

Bøggild: M. o. G. 25, 1902, p. 49.

Found as almost microscopically small crystals in cavities in the altered sodalite-syenite.

Nunasarnaussaq, northern side of (Steenstrup 1898). Small crystals in altered parts of the upper diabase layer. *a*, *c*, *i*, *e*, *r* and *n* prevailing. The faces well-developed, shining, with horizontal striae. The colour dark brownish-green.

Qernertit at Nûluk at Igaliko (STEENSTRUP 1888). Small crystals (1—2 mm) in fissures in diabase. Combination *a*, *c*, *r*, and *b*. The faces rather dull and curved; the colour a vivid yellowish-green.

Kingigtoq at Sydprøven (LAUBE 1870).

VRBA: Wien Akad. Sitzungsber. 69, 1874, p. 91.

Veins (up to 1 cm) of pistachio-green, granular and fibrous e. produced by alteration of hornblende. Pleochroism indistinct. Specific gravity: 3.446. Analysis undertaken by A. BÊLOHOUBEK: SiO_2 38.10, Al_2O_3 10.73, Fe_2O_3 17.57, FeO 8.87, CaO 21.46, K_2O 1.03, Na_2O 2.25, H_2O 0.48 = 100.49.

East-Greenland.

Døde Hus Plads (ɔ: site of dead house) (KRUUSE 1899). Crystallized (up to 5 mm) together with rock crystal and albite in cavities in gneiss. The combination the usual one, chiefly *a*, *c*, *r* and *n*; the faces always shining; the colour light yellowish-green.

Sorte Pynt (ɔ: black headland) (HARTZ 1892).

BAY: M. o. G. 19, 1896, p. 156.

Reported to have been found as beautiful, strongly curved crystals of greenish e. in a quartz vein in hornblende schist.

116. Allanite. $(Ca,Ce,La,Na)_2(Al,Fe,Be,Mg,Mn)_3[OH(SiO_4)_3]$.

This mineral is found in a number of different localities in Greenland and frequently in rather large quantities. Even though it is by no means rare in other parts of the world, it was, however, found for the first time during the voyages of GIESECKE, who mentions it from a number of localities, nearly always under the name of gadolinite. The mineral is in Greenland nearly always accompanied by large quantities of small zircon crystals. The faces are designated as in the case of epidote. In total 21 occurrences are known in West-Greenland and 14 in East-Greenland, but only some of the more significant will be mentioned in the following.

The Egedesminde district

Inugsulik (RINK).

RINK: Ngr. p. 44.

Found as rounded, irregularly shaped grains (up to 3 cm) in very large quantities in granite, accompanied by small zircon-crystals. According to RINK this a. contains less Al_2O_3 and more H_2O than the following.

Nûgâtsiaq at Ataneq (Atanarme[1])) Fjord (RINK).

RINK: Ngr. p. 44.

[1]) DESCLOIZEAUX (Manuel de Minéralogie, 1, p. 258) mentions a. from Atanarme in Norway; in all probability it is the above locality, which by mistake has been referred to Norway.

ENGSTRÖM: Undersökning af några mineral, som innehålla sällsynta jordarter, Upsala 1877.

ZENZÉN: Bull. geol. Inst. Upsala, 15, 1916, pp. 69 and 70.

Occurs together with zircon in granite as grains, most frequently of the shape of flat tables, without a distinct outline. Size 1—2 cm; specific gravity 3.32. Analyses have been undertaken by RINK (1) and by ENGSTRÖM (2)[1]).

	1	2
SiO_2	33.8	33.29
Al_2O_3	11.8	19.35
Fe_2O_3	—	3.31
Ce_2O_3	21.9	9.26
La_2O_3		1.04
Di_2O_3	—	6.97
FeO	15.8	10.67
CaO	10.5	11.04
MgO	—	0.40
K_2O	—	1.27
Na_2O	—	0.37
H_2O	1.7	1.54
ThO_2	—	1.17
	95.5[2])	99.68

ZENZÉN has undertaken investigations of a. from two occurrences bearing the superscription "Egedes Minde"; possibly they are both from Nungatsiaq. The one has a specific gravity of 3.42, and is isotropic with medium refractive index 1.69.

The other one, which is reported to belong to the part analysed by ENGSTRÖM, has a specific gravity of 3.363; it is also isotropic with a medium refractive index 1.673.

The Godthaab district.

Igdlorssuit (GIESECKE 12-8-1808).

STROMEYER: Gött. gel. Anzeigen, 1834, p. 737. — Pogg. Ann. 32, p. 288.

[1]) The analysis of RINK is not expressly stated to concern this locality, but the variety of a. which besides in this locality is also found at Augpalârtorssuaq and Pâtorfik; however, as Nûgâtsiaq is mentioned first, and as the mineral occurs in far greater quantities here than in the other localities, it is probable that the analysis is undertaken on the material from here. ENGSTRÖM's analysis has the heading Egedesminde and, as it will be seen, does not agree particularly well with that of RINK, but according to the above-mentioned reports it agrees still less with the mineral from Inugsulik. In this as in the other case it must, however, be taken into consideration that the analyses of RINK were undertaken in Greenland under very primitive conditions and thus cannot lay claim to any high degree of accuracy.

[2]) 3 % indefinable substances, perhaps Y_2O_3, 0.7 foreign substances and 0.5 loss.

Descloizeaux and Damour: Ann. de Chimie et Phys., 3. Sér. 59, 1860.

Crystallized in granite together with zircon. *a* and *c* occur, no terminal faces; according to Descloizeaux crystals of the usual epidote form are sometimes formed. Analysis undertaken by Stromeyer: SiO_2 33.02, Al_2O_3 15.23, Ce_2O_3 21.60, FeO 15.10, CaO 11.08, MnO 0.40, H_2O 3.00 = 99.43.

Qeqertánguaq (Giesecke 20-9-1808; Fæster 1944). Small grains of an irregular shape in light-coloured pegmatite-like bands in gneiss; size up to 1 cm. The substance isotropic.

Narssaq (Giesecke 15-9-1808).

Descloizeaux and Damour: Ann. de chim. et phys. 3. Sér., Vol. 59, 1860.

Crystallized in granite: Observed faces *a* and *c*. D. and D. regard the mineral as belonging to the group of allanites, more abounding in water and called orthite, which cannot otherwise in any respect be distinguished from the ordinary a.

Aliortoq (Giesecke 1808).

Giesecke: Catalogue of Minerals, p. 210.

Descloizeaux and Damour: l. c.

Found in irregularly shaped grains in granite. According to D. and D. it is strongly birefringent, which is otherwise very rare in the case of the Greenland allanites; by blowpipe it melts easily without intumescence.

Qilángarssuaq (Rink). Crystallized (1—6 cm) in granite together with small zircon-crystals. The form rather indistinct; *a*, *c*, and *r* occur.

Fiskenæsset (Giesecke 17-5-1809).

Descloizeaux and Damour: l. c.

Crystallized in granite. D. and D. refer it to the orthite group, like the mineral from Narssaq.

The Frederikshaab district.

Avigait (Rink).

Rammelsberg: Zts. D. Geol. Gesellsch. 24, 1872, p. 60.

Crystallized in very large quantities in pegmatite, together with small zircon-crystals. The crystals elongated parallel with the b-axis; predominant faces *a* and *c*, besides less developed *e*, *r*, *l* and *i*. Terminal faces rare and very incomplete; *o*, *n* and *d* (111) were found. The faces rather imperfectly developed, more or less curved and dull; the interior of the crystals very impure, penetrated by felspar which more particularly often entirely fills the middle areas. The colour black, in transmitted light brownish-green; no birefringence. Specific gravity 3.408, analysis undertaken by Rammelsberg (the locality Frederiks-

haab must in all probability stand for the neighbouring Avigait; Kingigtoq is partly somewhat farther off, partly it is from of old in the literature called Kingiktersoak), SiO_2 33.78, Al_2O_3 14.03, Fe_2O_3 6.36, Ce_2O_3 12.63, La_2O_3 5.67, FeO 13.63, CaO 12.12, H_2O 1.78 = 100.00. As to Avigait the reader is further referred to what has been said below under Ivigtut.

Kingigtoq (GIESECKE 10-6-1809).

LEONHARD: Oryktognosie, 1821, p. 390.

Crystallized (up to 3 cm) in granite together with small zircon crystals. The crystals prismatic with very imperfectly developed, indefinable faces.

Ivigtut.

DESCLOIZEAUX and DAMOUR: Ann. de Chim. et Phys. 3. Sér., Vol. 59, 1860.

Here mention is made of the samples of a. found at Ivikaet with rather well-developed crystals with *a*, *c*, *r*, *s* and *i*. In the older literature the name Ivikaet is frequently found by mistake for Ivigtut, but it is extremely improbable that a. really should have been found in that locality; it is a more likely supposition that the name here is a perversion of Avigait.

The Julianehaab district.

Ivnatsiaq (RINK). Crystals (up to 5 cm) in granite-pegmatite consisting of quartz, microcline and arfvedsonite, together with small zircon crystals. A. imperfectly developed with indefinable crystal faces.

Qeqertarssuaq, island outside (EBERLIN 1885). Irregularly formed masses (up to 4 cm) with very small quantities of quartz and felspar, and in addition very small quantities of a more glistening, fergusonite-like mineral. A. rather impure, full of cracks.

Sangmissoq (EBERLIN 1884). Small crystals (1—2 cm) in granite-pegmatite. The form rather indistinct; *a*, *c* and *r* prevailing. The faces dull with a greyish white or brownish crust.

East-Greenland.

Qáqarssuatsiaq at Aluk (GIESECKE 1-8-1806).

ALLAN: Trans. R. Soc. Edinb. 6, 1812, p. 345.

THOMSON: TILLOCK's Phil. Mag. 37, 1811, p. 278. — Trans. R. Soc. Edinb. 6, 1812, p. 371. — GILB. Annal. Phil. 44, 1813, p. 113. — Journ. des Mines, 30, 1811, p. 281.

ALLAN: THOMSON's Annal. Phil. 1, 1813, p. 108.

HAIDINGER: POGG. Ann. 5, 1825, p. 157.

DESCLOIZEAUX and DAMOUR: Ann. de Chim. et Phys. 3. Sér., Vol. 59, 1860.

Crystallized in granite together with small zircon crystals, the form as a rule very indistinct; HAIDINGERS measurings point towards the

occurrence of *a*, *c*, *r*, *n*, *d*, *q* and *m*. Specific gravity 4.0001. Analysis undertaken by THOMSON: SiO_2 35.4, Al_2O_3 4.1, Fe_2O_3 25.4, Ce_2O_3 33.9, CaO 9.2, H_2O 4.0 = 112.0.

The locality is historically significant; in spite of the fact that it is situated in a little frequented and not particularly accessible region it was the first place, where the mineral was found. GIESECKE's first shipment of minerals were captured by the English and sold to ALLAN, who took a. to be gadolinite, until THOMSON, by means of his analysis, proved it to be a new mineral, which he named after ALLAN. The crystal-form is figured by HAIDINGER as triclinic, and only by means of investigations of the mineral from other occurrences it was proved to be monoclinic.

Ingitait, northern side of (EBERLIN 1884). At a height of about 500 m between the place of observation and the camping place, large irregularly formed masses (up to 15 cm) were found in granite-pegmatite. Highly penetrated by fissures which are filled with pegmatitic masses.

Tâterât (EBERLIN 1884). Fragment of a large crystal (10 cm) from a pegmatite mass in fine-grained granite, tabular, parallel with *a*; besides *c*, *r* and *i* rather indistinct. The surface altered to limonite.

Akia at Anoritôq Fjord (EBERLIN 1884). Fragment of a larger crystal (7 cm) from granite-pegmatite. The rock most immediately surrounding the crystal was like the crystal itself crushed into fragments. Greatly flattened parallel with *a*; besides *c*, *e*, *r* and *l* were found; the faces imperfectly developed, dull, partly coated with limonite.

Kap Rantzau (EBERLIN 1884). Fragments (up to 5 cm) of flat crystals, partly found in granite-pegmatite. Flattened parallel with *a*; in addition *c*, *r*, *i* and *l* were found; the faces imperfectly developed, dull.

Karra Akungnak (EBERLIN 1884). The most pronounced allanite-locality in Greenland. A. is found crystallized in granite-pegmatite, together with magnetite and small zircon crystals. The length up to 25 cm. The form elongated and flattened parallel with *a*; in addition *r*, *i* and *l* were found; of terminal faces only *n* very indistinct. The faces on the smaller crystals sometimes rather well-developed and shining; on the larger most frequently the faces are extremely uneven, as if they were corroded. The colour black; in thin layers brownish or yellowish without birefringence.

Kap Bille (EBERLIN 1884) fragment of a crystal (2 cm) picked out of a granite-formation; *a*, *c*, *r* and *i*; the faces dull, somewhat curved. Birefringent and pleochroitic.

Ruds Ø (EBERLIN 1884). Crystals (up to 4 cm) in granite pegmatite. The shape rather indistinct (*a*, *c*, *r*, *m*); the faces greatly

decomposed, whereas the interior very pure, black and uncommomly shining.

Tingmiarmiut, southern side of (EBERLIN 1884). In a peak slightly outside the place of observation, west of the camping site, prismatic crystals were found (1—3 cm) very closely packed in gneiss. Combination: *a*, *c*, *r* The faces uneven, decomposed.

Greenland without known locality.

ENGSTRÖM: Undersökning af några mineral, som innehålla sälsynta jordarter, Upsala 1877.

ZENZÉN: Bull. Geol. Inst. Upsala, 15, 1916, p. 68.

ENGSTRÖM reports an analysis of a. from Greenland, undertaken by CLEVE with the following result: SiO_2 32.97, Al_2O_3 16.10, Fe_2O_3 4.65, Ce_2O_3 9.66, $(Di, La)_2O_3$ 10.65, FeO 9.52, MnO 0.90, CaO 12.40, MgO 0.16, K_2O 0.17, H_2O 1.96, ThO_2 0.33 = 99.47; specific gravity 3.37. ZENZÉN has undertaken investigations of the remainder of CLEVE's material and found that some of the fragments were isotropic, but the greater part birefringent with pleochroism; this is in part very great in brown and green colours. Specific gravity determined at 3.645, the medium refractive index at 1.6720 (1.628—1.695).

117. Zoisite. $Ca_2Al_3[OH(SiO_4)_3]$.

East-Greenland.

Franz Josephs Fjord (Den danske Østgrønlandsekspedition, 1929). At the head of this fjord, on the northern side, 200 m from the margin of Nordenskiölds Gletscher, some lenses in gneiss were found in a vertical wall of rock, 0.5 m above the level of the sea, and very striking because of their rosy colour. The investigation has proved that the mineral is zoisite, which in many respects greatly resembles the so-called thulite from Leksvik at Trondheim.

The occurrence seems to have been very thick; in spite of the rather unfavourable conditions many kilograms of pure material have been collected, the largest fragment weighing 2.5 kg. The greater part of the material seems to be very pure, so that only very few foreign minerals are to be met with in the powder, but there are also special layers, in which only about half is z., whereas the remainder is quartz, albite, calcite and other minerals. The pure material has a very loose consistency, so that when touched or rubbed large quantities of sand are loosened; the impure particles are much more coherent. The individual grains are small, generally with a cross-section of 0.1—0.5 mm, and it is hardly possible to find essentially larger individuals. The

shape of the grains is irregular; under a magnifying glass a number of shining faces are to be seen, either crystal faces or cleavage planes, but owing to the small size it will hardly be possible to determine the crystal form in detail.

Unicoloured and beautifully rosy, considerably more light-coloured than in the Norwegian occurrence; when the light falls through it, the individual grain shows no visible colour and consequently no pleochroism. Refraction and birefringence agree entirely with what is usually the case in the mineral, and in a convergent light the interference figure is bi-axial, positive, with a rather small axial angle. The dispersion is very strong with $r > v$, whereas the mineral from other places in that respect sometimes reacts in the opposite manner.

118. Erikite. $(Na,Ca,Ce)_2(Al,Ce,La,Di)_3[OH((Si,P)O_4)_2]H_2O$.

The Julianehaab district.

Nunarssuatsiaq (Ussing 1900).

Bøggild: M. o. G. 26, 1904, p. 93.

As far as can be seen, e. is a pseudomorph, the crystal form and the contents both being unknown minerals. The crystal form is rhombic, and a typical form is pictured in fig. 40 with the following faces: *a* (100), *b* (010), *c* (001), *m* (110), *o* (130), *d* (012), *g* (021), *r* (101), *t* (111); also other faces occur. The latter are frequently rather uneven, only a few of the prism faces being striated. No cleavage, the fracture uneven.

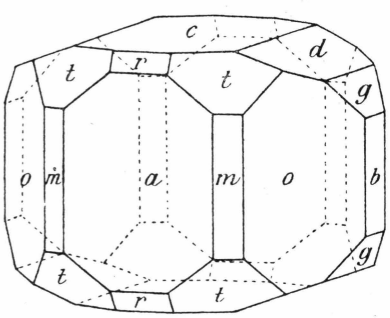


Fig. 40. Erikite. Nunarssuatsiaq.

Hardness $5^1/_2$—6, specific gravity 3.493. The colour is brownish or yellowish-brown, only transparent in thin sections.

Under the microscope e. proves to be of a rather complicated nature, as seen in fig. 41. We see here a network of linear elements in all possible directions; they are of a yellow colour (in the figure light greyish), and each of them is an aggregation of fine-grained consistency; they possess a strong refraction and birefringence. Between these

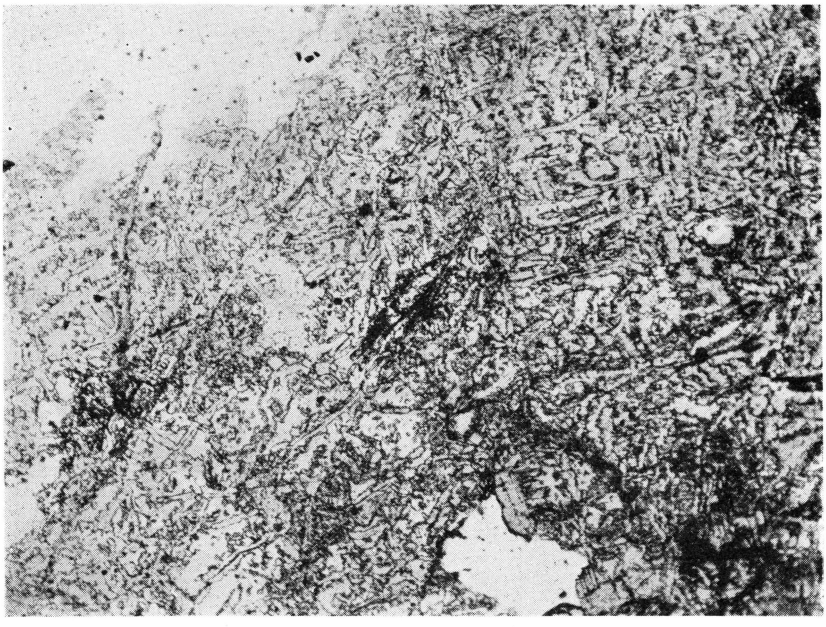


Fig. 41. Erikite. Nunarssuatsiaq. c. 50:1.

elements we see a ground-mass, which in the figure is almost black, in the sections of a brown colour; this mass is very fine-grained and seems to consist of the same substance as the rods, in some places there may be an intermixture of a zeolitic substance (not visible in the figure) the whole amount of which is not very large; its properties agree very well with hydronephelite.

Before the blow-pipe e. melts in thin splinters to a white enamel-like mass; it is decomposed by acids without gelatinization. Analysis undertaken by CHR. CHRISTENSEN: SiO_2 15.12, P_2O_5 17.78, $(Ce, La, Di)_2O_3$ 40.51, ThO_2 3.26, Al_2O_3 9.28, CaO 1.81, Na_2O 5.63, H_2O 6.28 = 99.67. It is hardly possible to establish any definite formula for the mineral, all the more as the exact proportion of quantity of the two constituents are unknown.

E. has been found in a very limited area in the syenite-pegmatite. The main mass originates from a single vein (about 1 dm) consisting of arfvedsonite, ægirine, analcite and natrolite. E. is as a rule older than these minerals, excepting ægirine with which it is frequently intergrown. A number of crystals are found projecting freely in cavities in lujavrite; they are more prismatic than the ordinary ones.

The mineral is named after Erik the Red, the colonizer of Greenland.

Naujakasik. In this locality which is situated on the southern side of Tunugdliarfik, opposite to the preceding one, a great deal of

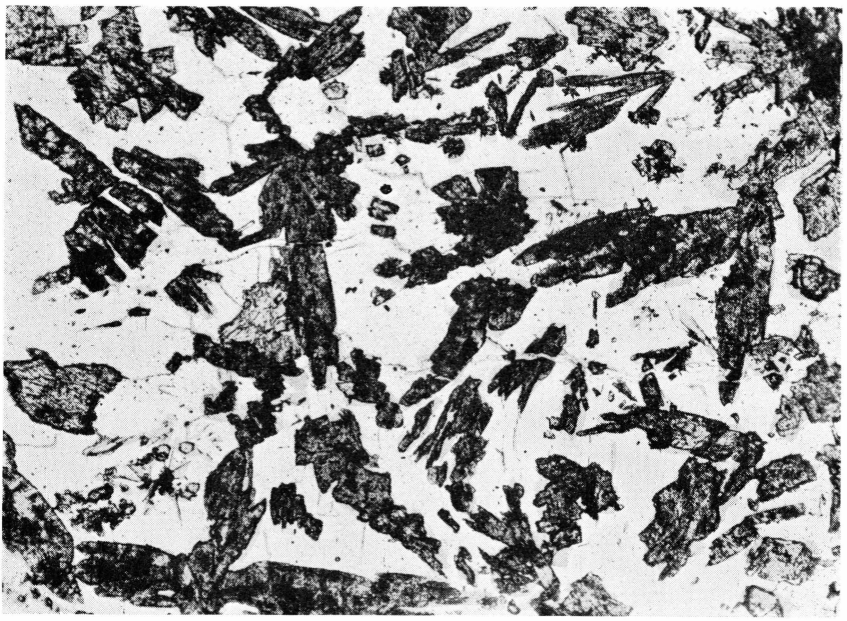


Fig. 42. Erikite(?). Naujakasik. c. 50:1.

material has been collected; it shows very characteristic points of resemblance with e. but also deviates in a number of details. The crystals are very imperfectly developed, and all that can be said is that they are in all probability rhombic. The mineral (fig. 42) consists of two substances, of which the yellow one (almost black in the figure) hardly makes half of it and floats freely in the zeolite-mass. The crystal individuals in the yellow substance are rather large (up to 2 mm), but very irregularly formed; they are optically uniaxial, positive; their refraction is a good deal greater than that of e. The colour is faintly brownish, and the zeolite-substance heterogeneous; sometimes there are polysynthetic twins (analcite); the manner of occurrence is like that of e.

Whether this mineral is to be classed with e., it may be difficult to decide, but it is certain that they offer certain analogies.

119. Ilvaite. $CaFe^{II}_2Fe^{III}[OH(SiO_4)_2]$.

In Greenland i. is only found in the region of Kangerdluarssuk. GIESECKE's collections comprised among others a mineral labelled jenaite (= i.) from Kangerdluluk in the Christianshaab district. JOHNSTRUP has demonstrated that the said mineral is in reality hornblende; however, this locality passed into the literature, first in LEONHARD's "Handbuch der Oryktognosie", 1821, later on in DESCLOIZEAUX' "Manuel de Minéralogie", 1862, where the name Kangerdluluk was corrected to Kangerdluarssuk, probably because this

locality was known as the finding place of a great number of rare minerals. Strangely enough the mineral has later on by chance been found in this very locality.

The Julianehaab district.

South Siorarssuit (Steenstrup 1876).

Flink: M. o. G. 14, 1898, p. 244.

Moesz: Math. és. term. tud. Ertesitö, 17, 1899, p. 242. — Ref. Zts. f. Kryst. 34, 1901, p. 708.

Bøggild: M. o. G. 25, 1902, p. 45.

Ussing: M. o. G. 38, 1911, p. 63.

Occurs in metamorphosed, post-archæan eruptives (nepheline-syenites and syenites) together with albite, microcline-microperthite, green garnet, epidote and a few other minerals, which will be mentioned elsewhere. I. itself has been produced by a transformation of the original dark minerals, ægirine and arfvedsonite, which clearly appears from the structure of the rock. The area in which i. occurs, is about 0.5 km², and the mineral is found in extremely great quantities, for the greater part finely crystallized. The crystals are rhombic sometimes very rich in faces, and a total of 29 different forms have been determined, ten of which are not known from other occurrences.

The most important forms, which are never lacking, and which as a rule bound the greater part of the crystal are *b* (010), *s* (120), *h* (210)

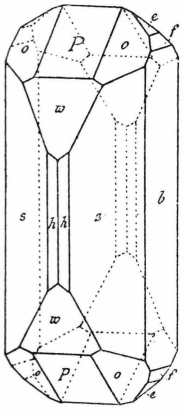


Fig. 43. Ilvaite. South Siorarssuit.

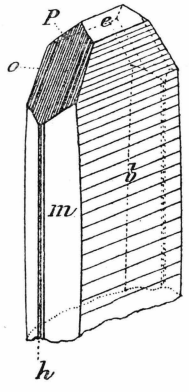


Fig. 44. Ilvaite. Kangerdluarssuk. (After Lorenzen).

and *P* (101) Otherwise the crystals from the various localities within the area mentioned are rather different in appearance, and 16 different types can be distinguished. As to further particulars see the author's treatise, quoted above; here only the principal type is to be mentioned, being bounded by *b* (010), *s* (120), *h* (210), *P* (101), *w* (301), *f* (041), *e* (021), *o* (111), fig. 43. The faces are very glossy and shining, with the

exception of *e* (021) which is entirely or partly uneven. The reflexes are good, but the values of the angles deviate a good deal from each other, which is due to the presence of numerous vicinal faces. Some of the edges are greatly rounded, whereas others are quite sharp.

The specific gravity is determined at 4.0065. Analysis undertaken by CHRISTENSEN (in BØGGILD): SiO_2 29.62, Fe_2O_3 19.48, FeO 33.28, MnO 2.20, CaO 14.38, H_2O 2.24 = 101.20. This agrees very well with the formula of the mineral which is $HCa\overset{II}{Fe}_2\overset{III}{Fe}Si_2O_9$.

Kangerdluarssuk (STEENSTRUP 1874).

LORENZEN: M. o. G. 2, 1881, p. 67 and 78. — Min. Mag. a. Journ. of Min. Soc. 5, 1882, p. 49.

LORENZEN: Zts. f. Kryst. 9, 1884, p. 243. — M. o. G. 7, 1893, p. 36. — Öfvers. k. Vet.-Akad. Handl. Stockholm, 1884, No. 2. — Meddelanden från Stockholms Högskola, 1884, No. 21.

In this locality i. only occurs in rather small quantities, but the manner of occurrence is essentially like that of the preceding locality, viz. in altered augite-syenite together with albite, green garnet and calcite. The crystals are about 1 cm in length, flattened along *b* (010), which face however is not developed, but replaced by a number of very steep domes. The most ordinary combination is *m* (120), *h* (210), *P* (101), *o* (111), *e* (021) (fig. 44). There is also a single massive and apparently quite pure fragment, weighing 1 kg.

The faces very glossy, but as a rule curved and striated; the most perfectly developed is *e* (021) which, however, shows greatly varying values of the angles. *P* (101) and *o* (111) are, as indicated on the figure, striated in the longitudinal direction. The manner of development of the faces in the prismal zones is particularly characteristic; *b* (010) is always replaced by steep domes which produce a strongly curved face, and at their upper ends the prisms pass into curved areas consisting of steep pyramids. LORENZEN has described such faces as (0.10.1), (0.12.1), (0.190.1) and (280. 840. 3), which can naturally not be determined with a fair degree of accuracy. Analysis undertaken by LORENZEN: SiO_2 29.30, Fe_2O_3 20.30, FeO 33.50, MnO 1.97, CaO 13.71, loss at ign. 1.90 = 100.68.

120. Zircon. $ZrSiO_4$.

Found in a number of localities in the older formations of Greenland, in the majority of places accompanied by allanite. Most of the crystals are very small (a few mm), and many of them are perhaps rather to be regarded as normal constituents of rocks. Only in a single case (Narssârssuk) very large crystals are found.

The Egedesminde district.

Inugsulik (RINK). Small crystals (2 mm) found in granite, together with allanite; prevailing forms (100) and (311), less (110) and in very

inconsiderable quantities (111). The faces sometimes well-developed, but most frequently more or less curved. The colour brownish grey.

Nûgâtsiaq (RINK).

RINK: Ngr. p. 44.

Crystals (up to 4 mm) found in oligoclase with quartz, biotite and allanite. Combination (100), (110), (311), (111) and (101) most frequently indistinct or lacking. The faces frequently well-developed, the colour dark-brown.

The Godthaab district.

Igdlorssuit (GIESECKE 12-8-1808). Is reported to occur crystallized in granite, together with magnetite and "ein gadolinitähnliches Fossil" (allanite).

Qilángarssuaq (RINK). Small (2—10 mm) crystals together with allanite in granite. Prevailing faces (100), (110), (311). The faces and the edges curved. The colour characteristically dark-red, pleochroism: ω vividly red, ε reddish grey with a brownish tinge.

Fiskenæsset (GIESECKE 1809). Very small crystals (0.5—1 mm) in granite together with allanite. Prevailing faces (100), (111), (311); less developed or lacking (110) and (101). The colour very dark-brown; the faces imperfectly developed.

The Frederikshaab district.

Avigait (RINK). Very numerous crystals (1—7 mm) with felspar, biotite and allanite. Combination (100), (110), (111), (311), (101). The faces sometimes well-developed, mostly curved. The colour reddish black; ω reddish; ε brownish.

Smallesund (EBERLIN 1883). Elongated small crystals (1—3 mm) in granite-pegmatite; combination as the preceding one; the faces rather well-developed, shining. The colour reddish black.

Kingigtoq (GIESECKE). Crystals (1—2 mm) together with allanite in granite. Combination (110), (100), (311), (111). The faces imperfectly developed, curved. The colour almost black with pleochroism: ω vividly red, ε brownishred.

Ivigtut (TAYLER).

TAYLER: Quart. Journ. Geol. Soc. London, 15, 1859, p. 607. — Manual of Greenl. p. 348.

Small crystals (2—4 mm) found in siderite, quartz and ivigtite in the pegmatite area in the western part of the cryolite-mass. The form rather deviating from the usual one, seeing that the double-pyramid (111) prevails, sometimes with small prismal faces (110) and (100). The crystals brown, opaque; the faces shining, somewhat curved.

The Julianehaab district.

Ivnatsiaq (Rink). Small crystals (1—3 mm) in granite-pegmatite consisting of quartz, microcline, arfvedsonite, barkevikite and allanite. The form elongated prismatic with (110), (331), (111) prevailing, (311) less pronounced. The faces rather well-developed. The colour pale brownish with pleochroism: ω reddish brown, ε yellowish brown.

Portusoq (Giesecke 23-6-1806, 7-8-1809).

Zirkel: Lehrbuch d. Petrographie, 1, 1866, p. 591.

Very closely packed crystals in granite consisting of microcline, quartz, hornblende, mica and magnetite. Size 2—20 mm, form and combination exactly like the preceding. The faces on the larger crystals dull, striated and grooved, on the smaller ones frequently well-developed. The colour reddish-brown. Pleochroism: ω reddish, ε brownish yellow.

Tuluvartalik (Garde). In all respects in agreement with the preceding, for which reason both occurrences may possibly be identical.

Igdlerfigssalik (Flink 1897).

Flink: M. o. G. 14, 1898, p. 255.

Reported to have been found in small quantities in pegmatite veins in syenite.

Narssârssuk.

Flink: Zts. f. Kryst. 23, 1894, p. 365.

Flink: M. o. G. 14, 1898, p. 231.

Flink: M. o. G. 24, 1901, p. 103.

According to Flink found in two different forms:

1. Rather considerable in size (up to 2 cm), combination: (110), (111) with small faces of (331). The faces most frequently curved, the colour ash-grey, faintly brownish. The faces have a peculiar silky, frequently also a pearly gloss. Opaque. These crystals have been formed at a very early stage and are found on felspar individuals, most frequently sunk into the albite crust surrounding the latter. On the zircon crystals often ægirine needles.

2. Size up to 1 cm. Nearly exclusively (111) with small faces of (100). The faces smooth and shining. The colour brownish to nearly black. The mineral faintly transparent. The crystals of this type are younger than the preceding ones; they are to be found on ægirine together with ancylite and yttriumapatite.

During later years crystals have been found in this locality, which are essentially larger than those otherwise found in Greenland. A particular mention must be made of 1) a well-developed crystal, 3.5 cm in length and bounded by (110), (331), (111), (311) and (301); 2) a rather imperfectly developed crystal, almost exclusively bounded by (111) with

very small faces of (110). The width of the crystal up to 3.5; and 3) a crystalline individual (6 cm long, 4 cm wide) entirely intergrown with ægirine, so that the zircon did not show a bounding of the crystals in the proper sense of the word, but only cleavage planes.

South Siorarssuit (Steenstrup).

Ussing: M. o. G. 14, 1898, p. 172.

Found in pseudomorphs after eudialyte-crystals together with felspar, zeolites and ægirine-acmite. The zircon is evenly distributed throughout the whole mass in irregularly shaped, colourless grains (up to 0.2 mm); sometimes very small crystals (up to 0.003 mm) are found, exclusively bounded by (111).

Qagssiarssuk (Rink).

Rink: Gr. II, App. p. 147.

Crystallized (2—8 mm) in ægirine with fine-grained felspar. Combination (111) most perfectly developed, (331) and (110) less pronounced. The faces shining, most frequently rather curved or striated; the colour brown.

South Kitsigsut Islands (Laube 1872).

Laube: Sitzungsber., Akad. Wien, 68, 1873, p. 85.

Laube describes z. as hyazinth-red grains with arfvedsonite and microcline; it is probably another locality and it is also possible that the mineral may be eudialyte (see that mineral).

East-Greenland.

Qáqarsuatssiaq (Giesecke).

Giesecke: The Miner. Geol. of Greenland. App. to G's Mineralogiske Rejse, 1816, p. 336. — Manual of Greenl., p. 327.

Very small crystals (about 1 mm) together with allanite in pegmatite. Form prismatic, bounded by (110), (100) and (111). The faces glossy and shining, the colour black, the crystals only transparent in very thin layers with a brown colour without pleochroism.

Qasíngortoq (Eberlin 1884). Crystals (2—6 mm) in pegmatite together with titanite, combination like the preceding, the faces glossy, as a rule curved. The colour brownish-black.

Akia (Eberlin 1884). Fragment of a crystal (3 mm). Combination (111), (100), (311); the faces greatly curved, shining. The colour reddish grey-brown.

Inugsuit (Eberlin 1884). Crystallized (1—4 mm) in quartz, felspar and hornblende which form veins in diorite dikes. (100) and (111) the prevailing ones, (311) and (110) less pronounced. The faces are as a rule rather dull, the colour very dark, brownish.

Karra Akungnak (Eberlin 1884). Crystallized in pegmatite, consisting of microcline, quartz, biotite, allanite, magnetite, beryl and other minerals. The crystals very small (about 1 mm) and not particularly numerous. (100) and (111) the prevailing faces; also (110), (331) and (311) occur. The faces well-developed, the pleochroism strong: ω reddish grey, ε yellowish brown.

Kap Bille (Eberlin 1884). Fragment of a crystal (about 8 mm) picked out of granite. (111), (311), (100), (110). The faces sometimes shining, sometimes greatly grooved and furrowed. The colour greyish-brown.

(Thorite).

This mineral is mentioned by Flink (M. o. G. 14, 1898, p. 231) as occurring at Narssárssuk, but on closer investigation he found the mineral to be zircon.

121. Rosenbuschite. $(Na,Ca)_2(Fe,Ti,Zr)[F(SiO_4)_2]$.

The Julianehaab district.

Nunasarnaq.

Ussing: M. o. G. 38, 1912, p. 151.

In a single fragment of naujaite colourless or faintly yellowish needles (up to 2 mm long) were found, mostly in the outer zone of sodalite crystals. The needles are monoclinic, elongated parallel with the b-axis and with a very distinct longitudinal cleavage. All the optical properties agree well with those of r.

122. Rinkite. $Na,(Ca,Ce)_2(Ti,Ce)[F(SiO_4)_2]$.

The Julianehaab district.

The region of Kangerdluarssuk (Steenstrup 1876).

Lorenzen: M. o. G. 7, 1893, pp. 4 and 41. Öfvers. K. Vet. Akad. Handl. Stockholm, 1884, No. 2. — Medd. från Stockholms Högskola, 1884, No. 2. — Zts. f. Kryst. 9, 1884, p. 248.

Brøgger: Zts. f. Kryst. 16, 1890, p. 87.

Flink: M. o. G. 14, pp. 238, 241 and 242.

Zambonini: Atta d. Soc. Ital. d. Sci. Nat. 60, 1921.

Gordon: Proc. Acad. Nat. Sci. Phil. 1924, p. 267.

Gossner and Kraus: Centralbl. f. Min. etc. 1933, A, p. 369.

Gossner and Kraus: Centralbl. f. Min. etc. 1934, A, p. 72.

As to the crystal form of the rinkite, opinions have differed very much. Lorenzen described it as monoclinic with the elements:

$$a:b:c = 1.56878 : 1 : 0.292199. \quad \beta = 88°47'14''.$$

The above figures can, however, only be regarded as approximate, as the faces are rather imperfectly developed. The faces observed are:

a (100), *s* (320), *m* (110), *h* (120), *n* (101), *u* ($\bar{1}01$) and *o* (341) (fig. 45). The crystals are generally flattened parallel with *a*, which is also a twin plane, so that the crystals are always composed of numerous twin lamellæ.

Hardness 5, specific gravity 3.45, the colour yellowish brown; the crystals are frequently corroded on the surface, the structure becoming earthy and the colour like that of straw. Frequently decomposed and undecomposed layers interchange with sharp boundaries, thus producing

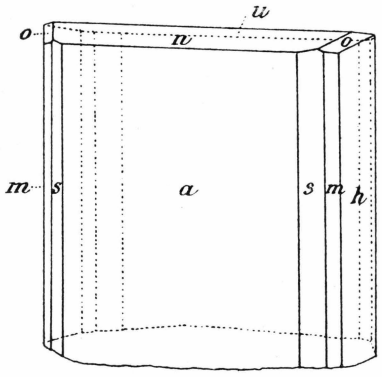


Fig. 45. Rinkite. Kangerdluarssuk. After Lorenzen.

a zonary structure, particularly parallel with *n* and *u*. The fresh mineral is translucent with vitreous lustre on the cleavage planes and greasy lustre on the fractures. The colour yellow in transmitted light.

Optically positive. The axial plane at right angles to *b* (010). and forming an angle of $82^1/_2°$ with the *c*-axis; the acute bisectrix is almost normal to *a*, and the axial angle, 2 E, is about 82°. The refraction is about 1.67, the birefringence rather faint.

Analyses have been undertaken by Lorenzen (1) and Chr. Christensen (2).

	1	2
SiO_2	29.08	26.89
TiO_2	13.36	5.42
ZrO_2	—	6.51
$(Ce, La, Di)_2O_3$	21.25	23.33
Y_2O_3	0.92	—
FeO	0.44	0.12
CaO	23.26	22.93
Na_2O	8.98	8.53
H_2O	—	3.82
F	5.82	5.00
	103.11	102.55
$\div$ O (= F_2)	2.45	2.11
	100.66	100.44

The chemical formula can hardly be deduced with certainty and must in any case become very intricate. BRØGGER refers to a rather close relationship with johnstrupite, which appears both in most physical and chemical properties, and which for that matter has become still more striking after CHRISTENSEN's analysis. The only pronounced difference is almost the different situation of the axial planes of the two minerals.

ZAMBONINI cannot find the twin lamellæ recorded by LORENZEN, which must be said to be very strange, as according to my experience they occur in great quantities in every section. In opposition to the obliquity of extinction of $7^1/_2°$, recorded by LORENZEN in sections parallel with (010), ZAMBONINI only finds a very small obliquity c. 0.5°, which more or less corresponds with what I have observed; the obliquity of the extinction it would in reality be very difficult to demonstrate without the twin lamellæ, which make them extremely distinct.

At Naujakasik GORDON found a single block with very small crystals (rarely more than 1 mm long), the habits of which are very different from those of all other rinkite crystals. For whereas the latter are bounded at the ends by the two planes, $(\bar{1}01)$ and (101), which are very nearly of the same size, so that the crystals become pronouncedly pseudorhombic, GORDON's crystals have pronouncedly monoclinic habits, the latter form being always absent. Owing to the excellently developed faces, GORDON's measurings are far more accurate than LORENZEN's, so that his elements: $a : b : c = 1.6614 : 1 : 0.6566$, $\beta = 78°34'$ are surely the best obtainable for the mineral. GORDON establishes LORENZEN's (101) as a base, which may be very natural for the crystals in question, but not for the usual ones, where the faces of the front and the back are so alike that it is hardly possible with certainty to distinguish them from each other.

GOSSNER and KRAUS have undertaken röntgenographic investigations of rinkite, and have arrived at the result that the crystals must be rhombic, which does not stand in accordance with the oblique extinction. In the second treatise the two authors touch upon the chemical formula of the mineral, as to which investigations the reader is referred to the treatise.

Rinkite may occur as a secondary accessory constituent of the nepheline-syenite in the Kangerdluarssuk area; in the pegmatite veins it frequently occurs in large quantities together with felspar, arfvedsonite, ægirine, eudialyte etc. The succession of the crystals is rather different; the rinkite is perhaps generally speaking among the first formed minerals, for which reason it may very frequently be found with rather perfect crystalline form, but very often it may also happen to be found as irregularly bounded grains. The crystals never attain

any considerable size. The maximum length is 3—4 cm, the width somewhat smaller and the thickness about 0.7 cm. The mineral is named after Dr. RINK, the director of the Royal Greenland Trade (the Administration of Greenland) who made very considerable collections of minerals and rocks in Greenland.

R. has not been found outside this locality. When in the 4th ed. of DANAS Textbook, 1932, it is stated that it occurs in Narssârssuk, this is due to a mistake.

(Johnstrupite).

Among the new minerals found by FLINK[1]) there is one which greatly resembles j. and originates from Iviangusat at Kangerdluarssuk. The mineral is not yet investigated in detail.

123. Lorenzenite-Ramsayite. $Na_2Ti_2[O(SiO_4)_2]$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 250.

FLINK: M. o. G. 24, 1901, p. 130.

BARTH and BERMAN: Chemie der Erde, 5, 1930, p. 40.

SAHAMA: The Amer. Mineralogist, 32, 1947, p. 59.

The Greenlandic mineral consists of very small crystals (length c. 1 mm, width c. 0.1 mm) and was only found in one of the sublocalities, mostly together with ægirine and elpidite. In FLINK's first paper he designed the mineral with the names "Needles with adamantine lustre" and "Darkbrown prisms", in the second paper he named it after the Danish mineralogist J. LORENZEN.

The essential properties of the lorenzenite, as given by FLINK, are the following. The crystals are rhombic, of two types: 1) bounded by (110), (120), (100), (010) and (111); 2) furthermore possessing (231) and (1.12.0); the crystals of type 1 are colourless in the middle and black at the ends, those of type 2 are brownish with pleochroism: lengthwise brown, crosswise darker violet-brown; hardness a little more than 6, specific gravity 3.42. Optically positive, the axial plane is (100), the acute bisectrix is normal to (010); the axial angle (2 E) is 72°. Refraction $\alpha = 1.7431$ $\gamma = 1.7876$. Before the blowpipe l. easily melts to a black globule, not decomposed by acids. Analysis by MAUZELIUS (in FLINK): SiO_2 34.26, TiO_2 35.15, ZrO_2 11.92, Na_2O 17.12, K_2O 0.37, H_2O 0.77 = 99.59.

In 1925 KOSTYLEVA (Bull. de l'Acad. des Sci. de Russie, 19, p. 363) described a mineral from Kola, which she called ramsayite after the

[1]) M. o. G. 14, 1898, p. 242.

Finnish mineralogist W. RAMSAY. The chemical composition resembles that of the l. with the exception, however, that the ZrO_2 is replaced by TiO_2; the different properties are much more easily determined in the large crystals, and it is seen that there is a very strong cleavage parallel with (100). The optical properties for both minerals were determined by BARTH and BERMAN, who found, that the sign is negative the axial angle, 2 V, is 25—49°, and the refraction is: $\alpha = 1.92, \beta = 2.01, \gamma = 2.02$. The ramsayite was generally considered a variety of the lorenzenite, until a new analysis undertaken by KNORRING and JOENSUU (in SAHAMA) obtained the following composition for the mineral from Narssârssuk: SiO_2 35.40, TiO_2 43.16, Nb_2O_5 3.89, V_2O_5 0.01, FeO 0.34, ZrO_2 0.07, CaO 0.19, SrO 0.01, Na_2O 16.23, Y_2O_3 0.02, La_2O_3 0.01, Ce_2O_3 0.04, F 0.38, H_2O+ 0.42, H_2O- 0.17 = 100.34 — 0 = 0.16 = 100.18.

As seen there is no essential difference between the composition of both minerals, and it will be most natural to count them as one mineral which ought to be called ramsayite. The inexactness of the examinations of FLINK and the analysis of MAUZELIUS may be explained by the very scanty material.

124. Titanite. *CaTi[OSiO$_4$]*.

The Umanak district.

Sâtúnguit (GIESECKE 4-6-1811). Occurs in microcline together with biotite, as crystals of the usual titanite form with (001), (100), (110), (111), (102), also sometimes ($\bar{1}11$) and ($\bar{2}21$). The crystals (up to 15 mm long), well-developed, with shining and plane faces; the colour brownish-black. In GIESECKE's diary the locality is said to be Sâtorssuit, whereas the label gives the name mentioned above; it is undoubtedly the same locality that is meant, though it is hardly possible to prove which.

The Jakobshavn district.

Anoritôq (STEENSTRUP 1871). Small (about 5 mm) crystals in fine-grained granite. The faces (001), (100) and (111) imperfectly developed, dull; the colour brown.

The Egedesminde district.

Manîtsoq (GIESECKE 26-8-1812).

RINK: Ngr. p. 41.

Found in somewhat different mineral-associations, among which special emphasis should be put on a white, fine-grained albite with interpositions or layers of actinolite in addition to scattered crystals of titanite; the latter may attain a diameter of up to 3 cm and have the

usual faces (100), (001) and (111); all the crystals are imperfect and broken. Another specimen consists of a more large-grained mass, the principal part of which is so impure that it can hardly be determined; a few small parts are plagioclase. This mass seems to form a layer in biotite schist, with titanite crystals of a very elongated form, most frequently with (111) as the only face.

Akugdlît (GIESECKE 1812). The sample from this occurrence resembles the latter so entirely in all particulars that there would seem to be a mistake as regards one of the labels.

Between Eqalugssuit and Nordre Strömfjord (FÆSTER 1939). Small grains (up to 5 mm in diameter) in granular scapolite; the form irregular, the colour black.

The Holsteinsborg district.

Maligíssap qâva (NYEBOE 1915). Small grains (up to 7 mm) together with scapolite and actinolite; the colour black; the crystal form very indistinct.

The Sukkertoppen district.

Tasitsat between Kûgssuaq and Sarfartôq in Söndre Strömfjord (HELWEG 1914). Crystallized in white, large-grained quartz; the crystals tabular, about 1 mm thick and 1 cm long. As it is impossible to remove them unbroken from the quartz, their boundaries cannot be accurately determined; faces (110) and (111) have been found; twins with twin plane (100). The colour light-brownish, as distinguished from all other occurrences in Greenland, where it is black-brown or black.

The Godthaab district.

Fiskenæsset (GIESECKE 15-9-1809). In a fine-grained rock chiefly consisting of labradorite larger individuals of augite and titanite are found. The form the usual one. The faces imperfectly developed, the colour dark-brown.

The Frederikshaab district.

Smallesund (EBERLIN 1885). Fragment of a single crystal (about 2 cm). Only form (111), imperfectly developed; the colour greyish-black.

East-Greenland.

Ilaliánguit at Kangerdluarak (KNUTSEN 1883). Crystallized (up to 6 cm) in gneiss; the only recognizable form (111) very irregular owing to felspar having grown into it. The colour dark-brownish.

Qasíngortoq (EBERLIN 1884). Crystallized together with zircon in pegmatite; usual form with well-developed faces; the colour dark-brown.

Kap Tordenskjold, the summit of (EBERLIN 1884). Crystallized in gneiss; usual form with very uneven faces; greyish brown.

Akia in Anoritôq (EBERLIN 1884). Some resemblance to the preceding; the crystals up to 3 cm.

Inugsuit (EBERLIN 1884). Small crystals in gneiss and pegmatite.

Kap Rantzau, the country round (EBERLIN 1884). To be found in pegmatite together with ilmenite in irregularly formed, rather large (up to 4 cm) masses, greatly mixed up with mica and quartz. The colour dark-brownish.

Karra Akungnak (EBERLIN 1884).

EBERLIN: M. o. G. 9, 1889, p. 255.

Found in great quantities and in larger dimensions than otherwise (up to 7 cm) in pegmatite. The crystals bent and broken, penetrated by numerous fissures; the form indistinct, the prevailing face being (110). The colour varies from yellowish brown to dark-brown. It is chiefly t. from this locality which EBERLIN bears in mind, when he writes that he has found yttrotitanite in East Greenland. However, a determination made by CHR. CHRISTENSEN shows that t. from this locality only contains infinitesimal qantities of yttrium, so that it can be looked upon as certain that the mineral y. has not been found in Greenland.

Kap Adelaer (EBERLIN 1884). A few small crystals in a granitic rock, in which there were also interpositions of actinolite. The faces partly very well developed.

Kap Bille (EBERLIN 1884). Fragments of crystals picked out of granite; no other recognizable faces than (111); the faces being as a rule very shining.

(Yttrotitanite).

As to this mineral the reader is referred to what has been said above of the titanite from Karra Akungnak.

125. Epistolite. $(Na,Ca)(Nb,Ti,Mg,Fe,Mn)[OHSiO_4]$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, pp. 247 and 257.

BØGGILD: M. o. G. 24, 1901, p. 183.

The crystals are monoclinic, but the crystals are developed in such a manner that they can hardly be used for the determination of the material, which is besides particularly recognizable because of its

characteristic physical properties. The form of the crystals is, as far as can be seen, always rectangularly tabular, formed like an ordinary letter, hence the name. Cleavage, parallel with (001) (the direction parallel to which the tabulae are flattened), very pronounced, less distinct in two directions of a prism, which form an angle with each other of 102°30′; the substance extremely brittle. Hardness 1—2; on (001) strong pearly lustre, otherwise vitreous lustre. Only very little transparent, on account of innumerable very small interpositions; the colour whitish, greyish or brownish. Specific gravity 2.885. Optically negative; the axial plane parallel with (010), the acute bisectrix forming an angle of about 7° with the normal on (001); on by the far greater number of specimens one of the optical axes will be seen at the edge of the field of view. Refraction (according to LARSEN's tables) $\alpha = 1.610$, $\beta = 1.650$, $\gamma = 1.682$; $2\,V = c.\ 80°$.

Before the blowpipe e. melts easily into a dark-brown globule; it is not dissolved by acid. Analysis undertaken by CHR. CHRISTENSEN: SiO_2 27.59, Nb_2O_5 33.56, TiO_2 7.22, FeO 0.20, MnO 0.30, CaO 0.77, MgO 0.13, Na_2O 17.59, H_2O 11.01 F 1.98 = 100.35 — O (= F_2) 0.83 = 99.52. From this composition it is hardly possible to deduce any reasonable formula. E. has been found in Kangerdluarssuk and on the small island Qeqertaussaq, in the latter; in greater quantities it has, however, been collected at the two occurrences Tugtup agtakôrfia and Nunarssuatsiaq at Tunugdliarfik. It is partly found in the actual pegmatite veins, but in still greater quantities in the masses of granular albite accompanying the latter. It may form tabulæ of up to 1 dm, several of which are frequently found together in a hypoparallel position or inter-crossing. E. is frequently formed before the adjoining minerals; thus it frequently has a crystal form, but owing to its being so brittle, it is impossible to extract the crystals. Only in a single case crystals have been found in a cavity. The mineral may be grown together in parallel position with rinkite and polylithionite; in the rinkite there are leaves of e., interposed parallel with the cleavage planes of r. In the polylithionite irregularly bounded areas of e. are very often found, occupying the centre of the large star-shaped planes and also sometimes in the outer parts of the latter; both minerals have parallel basic planes (cfr. fig. 68).

In FLINK's report the mineral was called "brucite" or a brucite-like mineral. It has not been found outside Greenland.

126. Steenstrupine. $(Na,Ca)_3CaCeNb[(OH,F)(Si,P)O_4]_3$.

The Julianehaab district.

The region of Kangerdluarssuk (STEENSTRUP 1876).

LORENZEN: M. o. G. 2, 1881, p. 73.

Flink: M. o. G. 14, 1898, pp. 257 and 258.

Moberg: M. o. G. 20, 1899, p. 245. — Zeits. f. Kryst. 29, 1898, p. 385.

Bøggild: M. o. G. 24, 1901, p. 203.

Thomsen, Jul.: D. k. d. Vid. Selsk. Overs. 1904, p. 53.

Zambonini: Atti. d. R. Acad. d. Sci. fis. e. mat. di Napoli, 14, No. 1, 1908.

Zambonini: Revista Christ. Min. Ital. 45, 1915, p. 180.

Machatschki: N. J. Min. Beil.-Bd. 64 A, 1931, p. 235.

Strunz: N. J. Min. Monatshefte, 1944 A, p. 244.

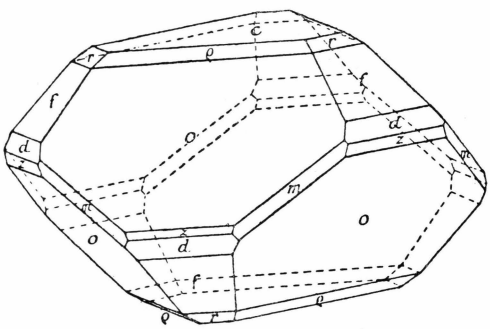


Fig. 46. Steenstrupine. Kangerdluarssuk. (After Moberg).

S. crystallizes rhombohedrically and can be referred to three, rather distinct forms.

1. By far the most common form. The crystals are fairly isodiametrical, besides c (0001), o (10$\bar{1}$1) being the most important; further may also occur smaller faces of ϱ (50$\bar{5}$9), z (40$\bar{4}$1), m (11$\bar{2}$0), r (01$\bar{1}$2), f (04$\bar{4}$5), d (02$\bar{2}$1) (fig. 46). These crystals are found on all occurrences south of Tunugdliarfik, partly at Naujakasik and Tuperssuatsiaq on the southern side of that fjord, and more particularly at Kangerdluarssuk itself. The size may be as much as 3 cm.

2. The form a fairly regular, hexagonal table with the positive and negative rhombohedrons equally developed. Has been found at Nunarssuatsiaq and Igdlúnguaq at the northern side of Tunugdliarfik.

3. Isodiametrical, the negative rhombohedrons d (02$\bar{2}$1) and f (04$\bar{4}$5) however prevailing, z (40$\bar{4}$1) and particularly o (10$\bar{1}$1) very small. The finding place Tugtup agtakôrfia.

Of these types no. 1 is completely altered, no. 3 completely fresh, whereas no. 2 occupies an intermediary position. Type 3 has a faint cleavage, parallel with the base, which is lacking in the others. In the fresh s. the colour is dark-brown with a colourless streak, in the others black, with a distinct brown streak. Hardness in type 3 slightly exceeding 5, in the others 4—5. Specific gravity in type 3 = 3.5122, in type 1 = 3.40—

3.47. The crystals of type 3 have dichroism: ε yellowish brown, ω lighter greyish-brown, and a constant negative birefringence: $\varepsilon = 1.660$, $\omega = 1.668$. Type 2 can be rather strongly birefringent along the edge, but isotropic in the centre; type 1 is entirely isotropic; it is very heterogeneous in thin sections, with nearly colourless areas, interrupted by streaks and spots of black or brown material; a fairly homogeneous refraction does not exist.

Before the blow-pipe s. melts easily into brownish or greyish glass; it is easily dissolved by acids. Analyses have been undertaken by Lorenzen (1), Blomstrand (2 and 3) on uncrystallized material, (4) on crystals of type 1, and Christensen (5) on crystals of type 3:

	1	2	3	4	5
SiO_2	27.95	20.61	21.30	26.57	26.72
ThO_2	7.09	3.84	4.13	3.03	2.13
Ta_2O_5	0.97	1.58	1.02	1.21	—
Nb_2O_5	—				4.37
P_2O_5	—	4.53	4.39	5.81	8.19
CeO_2	—	17.85	19.40	—	—
Ce_2O_3	10.66	—	—	14.40	
La_2O_3	17.04	15.52	16.68		29.60
Di_2O_3				15.90	
Y_2O_3	—	2.19	1.68		0.36
Fe_2O_3	9.71	5.18	4.91	4.55	2.67
Mn_2O_3	—	5.79	6.80	1.82	—
MnO	4.20	—	—	2.32	6.60
Al_2O_3	2.41	0.40	0.60	2.55	—
BeO	—	1.22	1.93		—
CaO	3.09	4.22	4.55	4.03	2.33
PbO	—	1.02	0.78	0.46	—
MgO	—	—	—	—	0.31
Na_2O	7.98	2.53	2.54	8.34	11.23
K_2O	—	—	—	0.50	—
H_2O	7.28	12.73	10.30	7.58	3.45
F	—	—	—	—	1.24
	98.38	99.21	101.01	99.07	99.20

Jul. Thomsen has investigated the gasses enclosed in the mineral and found that in 1000 g there was 1880 cm^3 for CO_2 freed gas, of which 480 H, 820 CO and 580 N. In his first treatise Zambonini has investigated the giving off of water by heating, and in his second he has considered the chemical structure. Machatschki very thoroughly discusses various conditions regarding the mineral, partly the crystal form, more particularly its resemblance with eudialyte, and partly its chemical composition and formula, and he also carries out röntgenographical investigations. However, it has not yet been possible to arrive at a fairly accurate formula for the mineral.

S. has a very wide distribution in the pegmatite veins and in the veins of granular albite which accompany the latter; on the other hand, it has not been proved to be a constituent of the actual rock. It has nearly always been formed before the other minerals of the veins, for which reason it has also in most cases a crystal form, and completely developed crystals are no rarity; only the ægirine can sometimes penetrate the crystals of s. Among the rarer minerals it is particularly often associated with epistolite, which sometimes is the first-formed of the two minerals.

S. was already brought home by Rink, who rather supposed it to be wolframite (Gr. II, App. p. 149); the specimen collected by Rink, which contained a number of well-developed crystals, has however until recently laid unnoticed in the collection. In 1876 Steenstrup sent home a large quantity of material; it was investigated by Lorenzen, who named it after the finder. During later years a very large material has been collected, especially by Flink and Steenstrup; Flink was the first to find the mineral on the northern side of Tunugdliarfik (type 2 and 3); he regarded it as belonging to a new mineral "bruna romboedrar", though hinting the possibility that it may be undecomposed s. The existence of the mineral has later on been proved in Kola, though in sparse quantities and non-crystallized.

127. Kornerupine. $(Al_2,Mg_3)[(Si,B)O_4]$.

The Jakobshavn district.

Sigssarigsut north of Jakobshavn.

Belowsky: Zts. d. D. Geol. Gesell. 58, 1905, p. 23.

Here a mineral in gneiss is described, which is supposed to be k. However, the few properties reported, such as colourlessness, fibrous structure, negative birefringence in the longitudinal direction of the fibres, a strong refraction crosswise, but faint lengthwise, is not sufficient to characterize the mineral, as they may equally apply to andalusite, topaz and other minerals, and the supposition that the refraction is much less than in apatite directly proves that the mineral cannot be k., the latter having a higher refraction than apatite.

The Godthaab district.

Fiskenæsset (Steenstrup 1877).

Lorenzen: M. o. G. 7, 1893 (Reprint 1884), p. 19.

Ussing: Öfvers. k. Vet.-Akad. Förh. Stockholm, 1889, Nr. 1. — Zts. f. Kryst. 15, 1889, p. 605.

K. crystallizes rhombically, but has very incompletely developed crystals without other faces than (010), (100) and (110); prismal angle 81°10′. The mineral most frequently occurs in radial- or parallel-fibrous aggregates. As a rule the single individuals are so closely packed that

there are no crystal faces on them; in sections interstices are, however, sometimes seen to be filled with mica or iolite and bounded by crystal faces. Sometimes the iolite-crystals are also found in the kornerupine, the minerals being grown together in a micro-granitic manner. Rather complete cleavage parallel with (110); hardness 6.5 and specific gravity 3.23 (LORENZEN), 3.273 (USSING). Vitreous lustre with white colour. Extinction parallel.

Analysis undertaken by LORENZEN: SiO_2 30.90, Al_2O_3 46.79, Fe_2O_3 2.02, MgO 19.46, H_2O 1.30 = 100.47, which rather accurately yields the formula $(AlO)_{12}$, $Mg_7H_2(SiO_4)_7$.

The manner of occurrence is described under sapphirine. K. is accompanied by sapphirine, mica, iolite and plagioclase, whereas the amphibole-minerals are found in small quantities or entirely lacking in the rock.

LORENZEN called the mineral after the Danish mineralogist KORNERUP, who has made a name for himself in the geological investigations of Greenland. But otherwise LORENZEN chiefly limited his work to a chemical analysis of the mineral, whereas the detailed crystallographic and optical investigation was undertaken by USSING. In 1886 there was a report from Saxony dealing with a new mineral of the name of prismatine, but in all respects it bears such a great resemblance to k. that there cannot be the least doubt that it must be the same mineral.

More doubtful is the report of LACROIX as to the occurrence of k. on Madagascar (Minéralogie de M., 1, 396, 2, 102 and 3, 303); this mineral deviates from the Greenland one, both by the very faint cleavage and by several differences in the chemical composition. The occurrence at Itrongay is for that matter peculiar in that k. is here found together with sapphirine, both of them in loose specimens unconnected with other minerals.

(Cappelenite).

A cappelenite-like mineral mentioned by FLINK (M. o. G. 14, 1898, p. 245) has on a later investigation proved to be britholite.

128. Tourmaline.

I $NaAl_8LiB_3[O,OH,FSiO_4]_6(OH)_{0-2}$.
II $NaAl_5Mg_4B_3[O,OH,FSiO_4]_6(OH)_{0-2}$.
III $NaAl_9B_8 \cdot [O,OH,FSiO_4]_6(OH)_{1-2}$.

T. is found in a great number of Greenland localities. It is everywhere the usual black variety, and the crystal form varies very little. Wherever both ends of the crystals are developed, the analogous and antilogous pole is certainly determined by means of the test with sulphur and minium. The designations of the faces are: m $(10\bar{1}0)$, m_1 $(01\bar{1}0)$, a $(11\bar{2}0)$, h_1 $(12\bar{3}0)$, r_1 $(\bar{1}01\bar{1})$, r $(10\bar{1}1)$, o $(02\bar{2}1)$ and e_1 $(10\bar{1}2)$. Pleochroism is only recorded by statement of the two colours, ω which is mentioned first always being the darkest.

The Umanak district.

Ubekendt Ejland (A. F. Møldrup 1888). It is labelled "U. E. district", so that it is rather doubtful which is the actual locality. The material is a pronounced schistose rock, the chief mass of which is dark-coloured and mostly consists of tourmaline, with smaller quantities of quartz, mica and a few other constituents. In it are found layers, which in thickness may change from nearly microscopical to up to 1 cm, and which chiefly consist of muscovite of a brownish-white colour and a strong lustre and besides a few small grains of magnetite enclose numerous tourmaline crystals. The latter are up to 1 cm in length and about 0.5 thick; the colour is black, in translucent light rather greenish brown with a pronounced pleochroism of the usual kind.

Storøen (Rink).

Rink: Ngr. p. 44.

Crystals (1 mm—1 cm) in pegmatite, consisting of albite, oligoclase and biotite in hornblende schist. The form short- or long-prismatic; on the smaller crystals the faces are well-developed. In the prism zone m_1 and a, r and o at the antilogous pole and r_1 at the analogous. The colour black. Pleochroism: dark-greenish grey — light-reddish brown.

The Christianshaab district.

Nûk (Rink). Crystals (up to 5 cm) in quartz together with oligoclase, biotite and garnets. The form indistinct; the faces curved; combination m_1, m, a and h_1 besides r, o and r_1. The prism faces strongly striated. Pleochroism: dark-yellowish brown to light-greyish brown.

Kangersuneq, northern side of (Sylow 1883). From a pegmatite vein in gneiss together with tremolite and sometimes rutile. Form m_1 and a, with m very narrow, besides r and r_1. Pleochroism: dark-bluish grey to light-reddish brown.

Qeqertarsugssuk (Sylow 1883). Crystals (up to 2 cm) in pegmatite consisting of quartz, felspar and muscovite. Combination m_1 and a, no terminal faces. The faces strongly striated and grooved, the crystals broken and penetrated by other minerals. Unusually strong absorption for both rays, ω dark-bluish, only visible in the very thinnest splinters, ε dark red-brown.

Ikamiut and Puagiarsuk (Giesecke 6-8-1812).

Leonhard: Handb. d. Oryktognosie, 1821, p. 402 (Peiaviarsuk).

Rink: Ngr. p. 44.

The manner of occurrence differently reported. Giesecke mentions t. in mica schist together with hornblende, Rink mentions white albitic felspar veins and connected with them layers with larger quantities of

quartz. The samples in the Mineralogical Museum of Copenhagen are pegmatite, consisting of quartz, oligoclase, biotite and garnets; sometimes chlorite and ilmenite. Some of the crystals are short (1 cm) and thick, bounded by m_1, a, h_1, r and r_1 with indistinct and curved faces. On another specimen there were long (up to 2 cm) very thin, almost needle-shaped and closely interwoven crystals. Sometimes m_1 and a are recognizable, but as a rule the prism zone is strongly striated. Pleocroism: dark-yellowish brown, light-greyish brown.

The Egedesminde district.

Manîtsoq (Giesecke 20-8-1812). Crystallized in a quartz vein in mica schist together with muscovite, garnets and molybdenite. Length of the crystals 2—15 mm. In the prism zone a prevails, while m_1 is less pronounced, and r very indistinct. Pleochroism: dark grey-brown to light-brownish.

Vester Ejland. Fragments of rather large crystals (length up to 8 cm, width up to 4 cm); a prevails, m_1 less pronounced. The faces uneven, partly coated with muscovite and other minerals. The difference of absorption great; very dark-bluish to light-reddish grey.

Qeqertarssuatsiaq at Nivâq Fjord (Koch 1908). Fragments of crystals (up to 4 cm) without other minerals, the form most irregularly rounded, without distinct faces, a and r fairly recognizable and also m_1 narrow. The colour black; pleochroism strong: dark-bluish grey to light-brown.

The Godthaab district.

Eqalúnguit (Kornerup 1878).

Kornerup: M. o. G. 1, 1879, p. 86.

Found together with beryl in a pegmatite dyke in gneiss, about 0.7 m wide. The crystals large (up to 8 cm long, 6 cm wide); in the prism zone m_1, a and h_1 occur, all with pronounced vertical striae, also m; at the antilogous pole r and o, at the analogous pole r_1 and e_1 the latter narrow and frequently lacking (fig. 47). All the faces for the greater part rather dull and irregularly developed. The absorption colours nearly as on Vester Ejland.

Björneö (Giesecke). Crystallized (up to 3 cm) in quartz. The faces very imperfectly developed, broken off and striated; only m_1 and a were found; pleochroism: dark-greenish grey to light-brownish red.

Qârusulik.

Schumacher: Nat. Selsk. Skr. 4, 2. Hefte, 1798, p. 228.

Schumacher: Versuch eines Verzeichnisses der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien 1801, p. 95.

Allan: Thomson's Ann. Phil. 1, 1813, p. 99.

Giesecke: Reise 22-9-1808.

Gruner: Gilbert's Ann. d. Physik 65, 1820, pp. 209 and 323.

Gmelin: Württ. naturw. Abh. 1, 2. Hefte, p. 226. — Pogg. Ann. 9, 1827, p. 172.

Rose: Abh. Berl. Akad. 1836, p. 215. — Pogg. Ann. 1836, p. 298.

Rammelsberg: Pogg. Ann. 80, 1850, p. 172. — Handb. d. Mineralchemie, 1875, p. 540.

Kornerup: M. o. G. 1, 1879, p. 82.

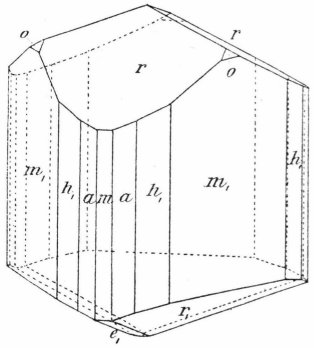


Fig. 47. Tourmaline. Eqalúnguit.

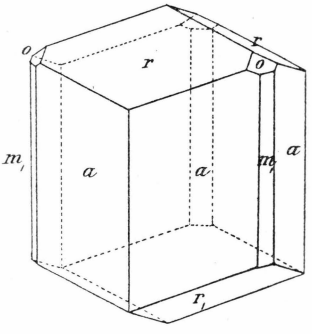


Fig. 48. Tourmaline. Qârusulik.

One of the most considerable and, from of old, well-known tourmaline localities. The occurrence which has been described and delineated by Kornerup consists of a coarse green mica schist, which forms a segregation in gneiss; in the mica the tourmaline crystals are found singly or in groups, frequently together with large quartz aggregates and fine needles of a light-green actinolite. Some of the tourmaline crystals are penetrated with fissures, filled with quartz. Sometimes the crystals are composed of several areas with a parallel orientation, sometimes they are found singly, with faces in all directions and of an uncommon regularity. The largest single crystal in Copenhagen belongs to the Agricultural College and measures about 13 cm in length and width and has a weight of 1972 gr. The combination of the faces is the usual one (a, m_1, r, o, and r_1) (fig. 48): m_1 is narrow, so that the cross-section of the crystal becomes almost purely hexagonal, o is quite small. The prism faces are very glossy and shining with a rather faint striation; the faces at the antilogous pole are very peculiarly developed with deep grooves and projecting lenses in all possible directions and frequently strongly curved; r_1 shows a somewhat similar phenomenon, but in a much lesser degree. Parallel with the r-faces there is sometimes a strong cleavage, possibly a relict of faces formed by the growth of

the crystals on which quite small mica leaves or similar have settled. Pleochroism strong: dark-bluish grey to light-reddish.

Analyses have been undertaken by GRUNER (1), GMELIN (2, specific gravity 3.026) and RAMMELSBERG (3, Pogg. Ann. and 4, Mineralchemie). It is not expressly stated that they all originate from this locality, but it appears from RAMMELSBERG's description of the crystals that it must be so, and in the case of the others it is rather probable.

	1	2	3	4
SiO_2	41	38.79	37.70	37.70
P_2O_5	—	—	0.11	—
B_2O_3	9	3.63	7.36[1])	7.82[1])
Al_2O_3	32	37.19	34.53	34.26
$FeO + Fe_2O_3$	5	5.81	4.88	4.42
MnO	1	tr.	—	—
MgO	3	5.86	9.51	9.51
CaO	—	—	1.25	1.25
Na_2O	—	3.13	2.00	2.00
K_2O	—	0.22	0.43	0.43
Li_2O	5	—	—	—
H_2O	—	1.86	2.23	2.61
	96	96.49	100,00	100.00

The analyses deviate a good deal from each other, and only the two last mentioned may be regarded as accurate. However, the quantity of iron, which is unusually small for a black tourmaline, points towards their being from the same locality.

The tourmaline from Qârusulik is well known. In the 18th century samples were collected by the Greenlanders and sent to Europe in such quantities that in 1813 ALLAN states that they are not lacking in any collection of minerals. GIESECKE was the first who found the locality; he calls the crystals the largest, which have ever been found of this mineral; however, in more recent times larger ones are known from a few other localities.

Qarajaq (SØRENSEN 1876). A single larger crystal and several very small ones found in fine-grained actinolite and for the greater part enclosed by a single dolomite individual. The prism zone consists of m and m_1, nearly uniformly developed with narrow faces of a; at the ends r, o, r_1 and e_1; pleochroism: dark-brownish, light-brownish.

Simiutaq (GIESECKE 19-9-1809). Crystals (2 mm—4 cm) together with quartz in mica schist; the faces (m, m_1, a and r) imperfectly developed, uneven and striated; pleochroism: dark-yellowish brown, light-reddish brown.

[1]) Determined as a remainder; H_2O is determined as loss by ignition; in analysis no. 3 it is recorded as F.

The Frederikshaab district.

Eqaluit (THOMSEN 1869). Thin prismatic crystals (about 3 cm in length) in chlorite schist. Faces only m_1 and a, almost equally developed; pleochroism: dark-greenish grey, light-yellowish grey.

Qaqortoq at Sânerut (RINK, STEENSTRUP 1888). Prismatic crystals in schist, consisting of quartz and felspar with garnets, 1—10 mm long. The consistency very loose, so that no crystals could be extracted unbroken, a predominating over m; pleochroism: dark-greenish grey to reddish yellow.

The Julianehaab district.

Kalitaut on the northern side of Sermersôq (JESSEN 1894).
JESSEN: M. o. G. 16, 1896, p. 139.
Elongated crystals (up to 8 cm) in pegmatite. The crystals often broken and re-cemented; a prevails, while m and m_1 are less pronounced; further r and e. The prism faces shining, strongly striated, the pyramid faces dull. Pleochroism: dark bluish-grey to reddish-grey.

Amitsoq (JESSEN 1894).
JESSEN: M. o. G. 16, 1896, p. 139.
In pegmatite, consisting of quartz, microcline and a little muscovite, there are numerous tourmaline crystals up to 4 cm in length. A few smaller crystals may have well-developed faces of m and a, but the greater part are very irregularly shaped. Pleochroism: dark-greenish grey to light-reddish.

Nanortalik (GIESECKE 6-8-1806).
LEONHARD: Hdb. d. Oryktognosie, 1821, p. 402.
Found together with small garnets in pegmatite veins, consisting of microcline, quartz and biotite. The crystals strikingly resemble those from Qârusulik (length 1—5 cm); a prevailing in the prism zone with narrow faces of m_1, also r, o and r_1. The properties of the faces and the pleochroism as in the case of the crystals from Qârusulik.

Erdluat qeqertât at Nanortalik (EBERLIN 1883). Elongated crystals (1—3 cm) in pegmatite. a prevailing, m_1 less pronounced, m quite narrow; besides r and r_1. The faces as a rule rather shining and regular. Pleochroism: dark-brownish green, yellowish green.

Ilua (SYLOW 1881). Crystallized (up to 6 cm) in clear, large-grained quartz, together with a small amount of muscovite. The crystals broken and re-cemented. In the strongly striated prism zone m_1 and a and others; no terminal faces; pleochroism: dark-greyish to light-yellowish green.

East-Greenland.

Aluk (Giesecke 1806). Crystals in quartz, length and width up to 4 cm. In the prism zone m_1 prevails; a is less pronounced, m very narrow; besides r, o, r_1 and e_1; the faces as a rule imperfectly developed. Pleochroism: dark greenish to yellowish.

Dronning Louises Ø, eastern side of (Eberlin 1884).

Eberlin: M. o. G. 9, 1889, p. 254.

In pegmatite together with garnets and andalusite; the crystals up to 5 cm long, irregularly developed and penetrated with quartz and felspar. In the prism zone m_1 and a equally developed, m narrow; at the antilogous pole r prevails, o and e $(10\bar{1}2)$ are very small; at the analogous pole r_1 prevails, also e_1. The faces rather shining; the prismal faces striated; the terminal faces irregularly grooved and pitted; pleochroism: brownish-black to light-yellowish.

Nagtoralik, south of (Eberlin 1884). Crystallized (1—3 cm) in pegmatite, together with garnets. The crystals irregular and skeletal. m, m_1 and a almost equally developed, besides r and r_1. The faces dull, deeply grooved.

Karra Akungnak (Eberlin 1884). Crystals (up to 6 cm) in granite-pegmatite, a prevailing over m_1, also r was found. The crystals imperfectly developed, often broken and then re-cemented. Dark greyish-black to light-yellowish.

Renodde (Bay 1892).

Bay: M. o. G. 19, 1896, p. 160.

Found in dykes in picrite; the outer part of the dyke consists of t. and hornblende, the inner part of light-coloured white or bluish plagioclase.

Kap Arends (Belgica 1905). Black masses (up to 5 cm) in albite, and also quite thin layers at the boundaries between the albite and the quartz veins in it. Under the microscope a fine-grained aggregate is seen or small crystals in the albite ground-mass. The crystals have greatly rounded faces, also sometimes curved. Pleochroism: very dark-bluish to light-brownish. In the tourmaline there are small grains of red garnet.

129. Calamine. $Zn_4[(OH)_2Si_2O_7] \cdot H_2O$.

The Julianehaab district.

Narssârssuk.

Gordon: Proc. Acad. Nat. Sci. Phil. 1924, p. 258.

Here white radial columnar aggregates are reported to have been found on sphalerite.

130. Astrophyllite. $(K_2Na_2Ca)(Fe,Mn)_4(TiZr)[OHSi_2O_7]$.

The Julianehaab district.

Narssârssuk.

Bøggild: M. o. G. 33, 1907, p. 103.

At the time of the publication of "Mineralogia Groenlandica", the mineral was unknown from this locality, but already in that year (1905) and in those immediately following, a rather large material was collected by the Greenlanders. The greater part of this has the characteristic form, described by the author and consisting of thin needles, or rather ruler-shaped bodies elongated parallel with the *a*-axis and flattened parallel with (010), which for the greater part forms a hair- and felt-like loose mass, though the needles may also be found grown into other minerals, as e. g. albite or catapleiite. The crystals attain a length of up to 1 cm, a width of 0.3 mm and a thickness of 0.16 mm, and they are not bounded by plane faces.

Later on other material has been produced. The thin crystals may be found grown together in the form of compact radial aggregates, but also crystals of a more common form occur. The latter may attain a rather considerable size, up to 4 cm in length, 18 mm in width and 8 mm thick. Besides by the cleavage plane (010) they are bounded by (100), or in any case by the adjoining faces and a pyramid, which in position seems to correspond with the form (434), but the development of the faces is so imperfect that it cannot be determined with certainty.

The region of Kangerdluarssuk (Nordenskiöld 1883).

Lorenzen: Öfvers. k. Vet.-Akad. Handl. Stockholm, No. 2. — Zts. f. Kryst. 9, 1884, p. 253. — M. o. G. 7, 1893, p. 45.

The material collected by Nordenskiöld was found on the island of Qeqertánguaq in a fine-grained rock, chiefly consisting of plagioclase and ægirine, like small shining, scattered leaves. The optical axial angle is very large. On a fragment of a crystal the faces (010) and (038) were found, both with striae parallel to the edge between them; further, two pyramid faces were observed which, however, cannot be determined in detail.

A fragment found by Steenstrup (1889) at Siorarssuit (probably North) greatly resembles this occurrence. More deviating is, however, a specimen of a., found in 1899 at Kangerdluarssuk and consisting of very small crystals in a loose mass of leucophanite, ægirine and felspar.

As to the occurrence of a. in pseudomorphs after ægirine, see this mineral.

(Rhodonite).

FLINK (M. o. G. 14, 1898, p. 242) mentions a mineral which is provisionally described as rhodonite-like; subsequent investigations have proved it to be a following mineral schizolite.

131. Wollastonite. [$Ca_3Si_3O_9$].

With certainty only proved to occur in a few localities, the various other occurrences mentioned in "Mineralogia Groenlandica" having, on closer investigation, proved to be okenite; the occurrences mentioned in the older literature but from which no samples are at hand, are naturally rather doubtful.

The Umanak district.

Marrait (RINK).

RINK: Ngr. p. 58.

FORCHHAMMER: Overs. K. D. Vid.-Selsk. Forh. København, 1864.

According to RINK found in greater quantities than any other zeolite, forming veins which in all directions penetrate the very much decomposed basalt or basalt tuff. W. is asbestus-like with fibres which may be fairly easily separated, and pierce the skin; the length of the fibres may be up to 25 cm. Sometimes the mineral has regular parallel fibres, but there are often parts with the fibres crossing each other, and then the mineral is in possession of an exceedingly strong coherence; in some parts calcite individuals are rather common. The analysis was first undertaken by RINK, who does not mention the figures, but gives the formulas $6\,CaSiO_3 \cdot H_2O$ and $8\,CaO, 9\,SiO_2$; and afterwards by FORCHHAMMER: SiO_2 49.82, Al_2O_3 0.64, CaO 45.02, H_2O 1.82, CO_2 3.20 = 100.50, and CHR. CHRISTENSEN: SiO_2 50.34, Fe_2O_3 0.19, CaO 47.13, H_2O 2.78 = 100.44.

Both analyses show with certainty that the mineral has the composition of wollastonite, but the optical properties of the needles do not very well agree with those of other wollastonites. Under the microscope all the needles have a double refraction which is positive lengthwise, whereas the wollastonite, which has the optic axial plane normal to the two cleavage directions, by pulverisation gives small needles mostly positive but sometimes also negative. Because of the bad crystallographic material it is impossible to make a more perfect examination of the optics of the mineral in question.

RINK calls the mineral asbestus-like okenite; when immediately afterwards he mentions another mineral, with a radiating fracture which he calls okenite, and which occurs in the form of veins associated with the preceding, it may be doubtful, what he is thinking of.

The Ritenbenk district.

Sarfârssuk (GIESECKE 10-7-1811). From here GIESECKE reports the finding of SCHUMACHER's so-called asbestus-like zeolite. Specimens in the Mineralogical Museum of Copenhagen agree completely with those from the preceding locality.

Ritenbenk coal-mine (GIESECKE 17-7-1811). The asbestus-like zeolite mentioned here may possibly be w.

The Godhavn district.

Godhavn.

SCHUMACHER: Versuch eines Verzeichnisses der in den Dänish-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 25.

Here zeolite-shaped asbestus is mentioned which, from the description, in all respects agrees with okenite; also occurrences as round or flattened boulders which are so common in the okenite of the Godhavn district. There is only one thing which does not agree, viz. the specific gravity; it is recorded to be 3.035, which is even too high for w., but naturally still more so for okenite. The actual nature of the mineral cannot be determined.

132. Pectolite. $Ca_2NaH[Si_3O_9]$.

The Greenland mineral resembles so completely the wollastonite mentioned above that it is very difficult to distinguish those from each other without an analysis. There is only one occurrence which is absolutely certain.

The Umanak district.

Svartenhuk (ROSENKRANTZ 1947). In the large valley between Umîvik and Umiarfik there was, besides other minerals, collected a sample resembling perfectly the p. from the next locality.

Niaqornat (RINK). The material consists of loose specimens without any rock attached to them, probably from fissures in the basalt, in the shape of a white fibrous aggregate; the fibres are sometimes parallel, sometimes radiating. In cavities small crystals (up to 5 mm in length) are found, elongated along the *b*-axis, with the forms (100), (001), ($\bar{1}01$), ($\bar{2}01$), ($\bar{1}04$), (340), (140). The faces rather imperfectly developed and striated, and particularly the faces of the prism zones are very irregular.

The crystals are completely colourless and transparent. The mineral rather luminous when strucked with a hammer. The optical conditions are generally speaking as usual; the obtuse bisectrix forms an upward angle of 17—22° with the normal on (100), the optical axial angle, $2H_0$, is measured at 150°. Analysis undertaken by CHR. CHRISTENSEN; the material used was nearest the crystals, which made the impression of being extremely pure, as also appears from the analysis, where the theoretical values are added in paranthesis: SiO_2 54.32 (54.2), Fe_2O_3 0.11, CaO 34.00 (33.8), Na_2O 9.32 (9.3), H_2O 2.55 (2.7) = 100.30. There were traces of CO_2.

The Ritenbenk or Godhavn district.

Disko.

CHESTER: Amer. Journ. Sci. 33, 1887, p. 284.

Without any definite locality mention is made of white confusedly fibrous masses, the so-called okenite, with an almost pearly lustre. Analysis: SiO_2 52.86, Al_2O_3 0.71, CaO 34.33, Na_2O 7.50, K_2O 0.47, H_2O 4.70 = 100.57. The material in reality can easily be thought to originate from Niaqornat.

In connection with the pectolite mention should be made of a mineral recorded but not determined in detail by Ussing[1]) from Kangerdluarssuk in the Julianehaab district. In the pseudomorphs after eudialyte from sodalite-syenite catapleiite and smaller quantities of felspar and acmite are found, and also small colourless or greenish needles, which are most frequently grouped in small bunches or bundles. The needles have a parallel extinction with the smallest optical elasticity axis in the longitudinal direction; pronounced lengthwise cleavage. It is probably a new zircon-bearing mineral of the pectolite-series.

133. Schizolite. $(Ca,Mn)_2NaH[Si_3O_9]$.

The Julianehaab district.

The region of Kangerdluarssuk (Steenstrup 1888, Flink 1897).

Flink: M. o. G. 14, 1889, pp. 241, 245, 257).

Winther: M. o. G. 24, 1901, p. 196.

Bøggild: M. o. G. 26, 1904, p. 121.

The crystals are triclinic; the most commonly occurring faces are a (100), b (010), c (001), n ($\bar{1}01$), r ($\bar{1}02$), which are hardly lacking in

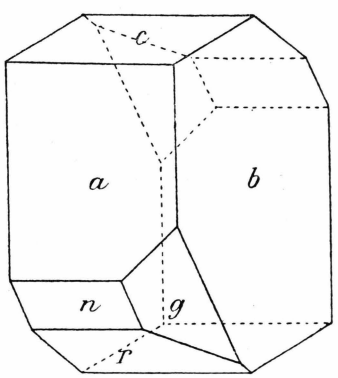


Fig. 49. Schizolite. Kangerdluarssuk. (After Bøggild).

any crystal; to these must be added g ($\bar{1}\bar{1}1$) and various rarer and smaller forms. The usual appearance of the crystals varies a good deal, but in the main they may be referred to two types.

1. Crystals, up to 5 cm long, elongated along the b-axis and also flattened along a (100); they occur at Kangerdluarssuk and Tugtup agtakôrfia.

2. This type is upon the whole isodiametric or flattened along (010); the most usual form is shown in fig. 49. These crystals occur

[1]) M. o. G. 14, 1898, p. 170.

together with the preceding ones at Kangerdluarssuk and also at Naujakasik and Siorarssuit North; in the latter locality only one crystal has been found, which in return is much larger than the other ones (diameter about 5 cm). In the smaller crystals twins are rather common; the twin-axis is the *b*-axis, revolution 180°; the face along which they have grown together rather coincides with *a* (100).

The faces are as a rule not striated but most frequently rather dull; only on some of the smaller crystals they are sometimes rather shining. There is a very strong cleavage along *a* (100) and *c* (001) with an angle of 84°4′ between them. Hardness 5—5.5; specific gravity rather varying. The fresh crystals from Tugtup Agtakôrfia are rosy, the more transformed, especially all of those from the other localities, are brownish or yellowish. Vitreous lustre, on cleavage planes pearly lustre. The crystals as a rule rather opaque, semi-transparent.

Optically positive; the acute bisectrix (= Z) is parallel with the *b*-axis; in any case it is hardly possible to prove oblique extinction on the crystals or the cleavage planes. The obtuse bisectrix forms in front an angle of 9° with the normal on (001). The axial angle, 2 E, is about 82°40′.

Analyses have been undertaken by Chr. Christensen; no. 1 is of type 1 from Tugtup agtakôrfia, no. 2 of type 2 from Naujakasik (both in Winther); no. 3 is of type 2 from Kangerdluarssuk (in Bøggild).

	1	2	3
SiO_2	51.06	51.44	51.06
TiO_2	0.68	—	0.62
Ce_2O_3	1.47	—	0.94
Y_2O_3	—	2.40	1.03
FeO	2.79	2.01	2.74
MnO	12.90	11.69	9.84
CaO	19.48	20.53	22.89
MgO	—	0.13	—
Na_2O	10.71	9.50	9.97
H_2O	1.36	2.25	0.55
	100.45	99.95	99.64

It seems impossible to deduce any single indisputable formula from these analyses, but they are at any rate in fairly good accordance with the formula $NaH(Mn, Ca)_2Si_3O_9$ in which also the undoubted relationship with the two preceding minerals, viz. pectolite, $NaHCa_2Si_3O_9$ and wollastonite $Ca_3Si_3O_9$ stand out clearly. Röntgenographic investigations have proved that all the three minerals are triclinic, but there is the difference that the two other minerals, both in crystal form and optical properties, are monoclinic, whereas the schizolite is only monoclinic in optical properties, and the crystal form is pronouncedly triclinic (the angle between *a* (100) and *b* (010) is 76°49′).

When heated s. gives off very little water; before the blow-pipe it melts easily to a faintly yellowish green glass, and it is decomposed by acids with gelatinization.

S. occurs in the pegmatite veins and in the veins of granular albite which accompany them. At Tugtup agtakôrfia, where all the minerals are quite fresh, it occurs in a snow-white, fine-grained albite of a considerable solidity; it is found in scattered crystals or in star-shaped groups. Accompanying minerals are ægirine, epistolite, steenstrupine, microcline, polylithionite and sphalerite. At Kangerdluarssuk it is found in a mass of granular albite, accompanied more or less by the same minerals. At Naujakasik it is found in pegmatite, consisting of microcline, arfvedsonite, ægirine, eudialyte, sodalite, nepheline, polylithionite and smaller quantities of steenstrupine and rinkite; it may be found enclosed in these minerals, and it may also project in cavities between them.

S. was first found by Steenstrup at Siorarssuit North, but was uninvestigated until 1897, when Flink collected a fairly large quantity of it. Owing to the different appearance of the mineral he called it by different names, such as rosy columns, cube-like mineral and rhodonite-like mineral. The two first mentioned forms were investigated by Winther, who named them according to the strong cleavage; as the forms investigated were incompletely developed from a crystallographical point of view, s. was supposed to be monoclinic, chiefly because of its optical properties. By means of the more completely developed crystals from Kangerdluarssuk Bøggild determined the mineral as triclinic.

At Kola smaller quantities have been found at a late period, partly rather large crystals rich in manganese.

134. Elpidite. $Na_2ZrH_6[Si_3O_9]_2$.

The Julianehaab district.

Narssârssuk (Lütken's Collection 1893).

Lindström: Geol. Fören. Förh. Stockholm, 16, 1894, p. 330.

G. Nordenskjöld: ibid., p. 343.

Flink: M. o. G. 14, 1898, p. 230.

Flink: M. o. G. 24, 1901, p. 146.

Bøggild: M. o. G. 33, 1907, p. 118.

Crystallizes rhombically, as a rule in the form represented by fig. 50 which is bounded by *a* (100), *b* (010), *c* (001), *m* (110), *n* (120) and *d* (011); there are a few other faces, but the crystals are rarely well-developed and then always very small. The larger crystals, up to 1 dm long and 1—2 cm thick, are always incomplete and frequently very

much bent and broken or cleft into thin points at one end. The crystals are often grown together in a confused, felt-like mass, more or less compact. A form which is to be found in the BERNBURG collection, has been described by the author; it solely consists of thin needles, which are fresher than the material otherwise seems to be; the length of the needles may be as much as 2 cm, the thickness most frequently a fraction of a millimetre.

Pronounced cleavage parallel with (110), with an angle of 54°3′, that is very nearly as in the amphiboles. The specific gravity is, according

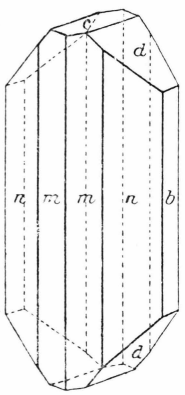


Fig. 50. Elpidite. Narssârssuk. After FLINK.

to the freshness, 2.598—2.524; the hardness of the fresh material is a little more than 7. The small well-developed crystals are either clear and colourless or enamelled, the larger are opaque and may be whitish, greyish or yellowish; most characteristic is, however, a brick colour by which the mineral is as a rule easily distinguishable. The lustre of these minerals is silky or entirely dull, and it is generally very inconspicuous in appearance and not very different from half-rotten wood.

The optic axial plane is parallel with *b* (010); the acute bisectrix is parallel with the *c*-axis. In yellow light α is 1.5600, β 1.5650, γ 1.5739, from which $2V = 75°12'$. In the fibrous material I have found $2V = 89°40'$.

When heated the mineral gives off a great quantity of water; it melts easily, and is not dissolved by acids. Analysis undertaken by LINDSTRÖM: SiO_2 59.44, ZrO_2 20.48, FeO 0.14, CaO 0.17, K_2O 0.13, Na_2O 10.41, H_2O (below 100°) 3.89, H_2O (above 100°) 5.72, Cl 0.15, CuO tr. TiO_2 tr. = 100.53 from which the formula $Na_2H_6ZrSi_6O_{18}$.

E. is one of the most widely distributed minerals at Narssârssuk, and it is found together with most of the other minerals occurring in that locality; the felt-like masses frequently enclose crystals of leucosphenite, epididymite, albite and other minerals. The name it now bears

has been given to it by LINDSTRÖM, being derived from the Greek word for hope, as this mineral and those occurring together with it in the LÜTZEN collection made it likely that the locality might be a very rich mineral occurrence. Elpidite is also known from Rockall, whereas a mineral from Kola, called titanoelpidite, and with a very large quantity of Zr replaced by Ti, should, it seems, be regarded as an independent mineral owing to its rather deviating physical properties.

E. also occurs as a constituent of pseudomorphs, and among them special attention should be paid to those after calcite, viz. a single larger crystal (5 cm long, 2 cm broad) and a few smaller ones, and even though the faces are extremely uneven, the form is distinctly seen to be the not unusual combination $(11\bar{2}0)$, $(21\bar{3}1)$, $(10\bar{1}1)$. It is hardly to be thought that this form should originate from any other mineral, but it is naturally strange that this combination is not known from Narssârssuk, and also that all calcite crystals from that locality are essentially smaller. The elpidite has the usual appearance of the mineral and consists of an aggregate of fine fibres, orientated in all possible directions.

As to elpidite as pseudomorphs after eudialyte, see this mineral.

The region of Kangerdluarssuk. As to the reported occurrence of pseudomorphs of e. after eudialyte see this mineral.

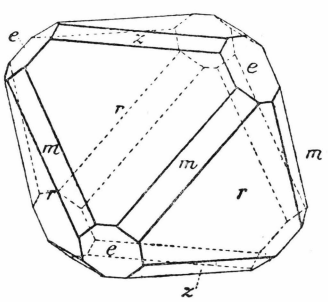


Fig. 51. Eudialyte. Narssârssuk. After FLINK.

135. Eudialyte. $(Na,Ca,Fe)_6Zr[(OH,Cl)(Si_8O_9)_2]$.

The Julianehaab district.

Narssârssuk (JESSEN 1894).

FLINK: M. o. G. 14, 1898, p. 231.

FLINK: M. o. G. 24, 1901, p. 90.

In this locality e. is very pronounced in both its principal forms, e. in the stricter sense of the word, and eucolite.

1. E. in the stricter sense of the word is of rather sparse occurrence, partly as crystals, partly as irregularly shaped masses wedged in between felspar, ægirine and quartz. The crystals, the size of which may

be as much as 3 cm is bounded by c^1 (0001), r (10$\bar{1}$1), z (10$\bar{1}$4), e (01$\bar{1}$2) and m (11$\bar{2}$0) (fig. 51); the faces uneven and dull.

Part of the substance of the eudialyte is clear and transparent, of a more pure and intensive red colour than is otherwise the case with e. FLINK describes it as isotropic, but at least in a part of the subsequently collected material there is a distinct birefringence with a positive sign, which according to FLINK is limited to portions along fissures in the crystal. Another part of e. is completely altered to a mass of brownish or yellowish grey colour, most frequently of a very brittle consistency; under the microscope a mixture of ægirine, zeolites, zircon and other minerals is visible. This altered substance is more particularly found in the outer parts of the crystal individuals or through the whole individual. Analysis of the fresh e. has been undertaken by CHR. CHRISTENSEN: SiO_2 50.39, Nb_2O_5 0.41, ZrO_2 12.40, FeO 6.70, MnO 2.74, CaO 9.12, Ce_2O_3 3.05, Na_2O 14.18, Cl 1.29, H_2O 0.26 = 100.54.

As early as in 1893 (Geol. Fören. Förh. Stockholm, 15, 1893, p. 208) FLINK mentions eudialyte crystals together with neptunite, epididymite and other minerals from Narssârssuk. LINDSTRÖM (ibid. 16, 1894, p. 330) states that these crystals originate from Kangerdluarssuk. In Zeits. f. Kryst. 23, 1894, p. 366 FLINK again mentions e. among minerals from Narssârssuk, viz. a brown crystal, which according to the description seems to originate from Naujakasik, and a pseudomorph which may as well originate from one locality as from another. With certainty e. was first found in this locality by JESSEN in 1894; later on FLINK and others have collected more ample material.

Among the material from this locality there are also a few pseudomorphs after e. consisting of a mixture of ægirine and elpidite. The crystals are partly large, up to 8 cm in diameter and well-developed with easily distinguishable faces, even though the latter are naturally rather uneven and dull. A few pseudomorphs are found grown together with ægirine crystals, a single one also with narsarsukite; otherwise they are very different from each other as to colour; a few of them have the brick colour which is characteristic of the elpidite, whereas the others are more purely light-grey, but microscopical investigations show that also here elpidite occurs. That e. is altered to elpidite and ægirine is very natural, as the chemical composition is not changed very much by this process.

2. Eucolite. In the years 1907 and 1908 a number of specimens collected by Greenlanders have been sent to the Mineralogical Museum of Copenhagen; as to the occurrence there can hardly be any doubt, as the specimens had not only been sent with minerals from there but were also found together, not only with felspar and ægirine, but also

[1]) The letter dropped in the figure.

with neptunite. The single individuals seem to attain a diameter of several centimetres, but it is difficult to separate them from each other, and no bounding of crystals has ever been observed. The mineral is a very pronounced eucolite, which has otherwise not been found in Greenland; the colour is brown without the reddish tinge which characterizes the Norwegian mineral; the fresher parts are clear and deep-brown, but larger parts are decomposed and light-brown. Under the microscope the clear parts are everywhere seen to be penetrated by fissure-like formations, where the mineral is altered to a brownish substance, which cannot be determined in details. The optical sign is everywhere negative, but the birefringence decreases strongly in the decomposed areas.

The region of Kangerdluarssuk (GIESECKE 28-8-1806).

ALLAN: Thomson's Ann. of Phil. 1, 1813, p. 103.
STROMEYER: Götting. gelehrt. Anzeigen, 1819, p. 1993.
PFAFF: Schweigger's Journ. 28, 1820, p. 97.
PFAFF: Schweigger's Journ. 28, 1820, p. 102.
PFAFF: Schweigger's Journ. 29, 1820, p. 283.
HAÜY: Traité de Minéralogie, 4, 1822, p. 485.
PHILLIPS: Mineralogy, 1823, p. 122.
WEISS: Verh. d. Ges. nat. Fr. 1, 1829, p. 197.
LEVY: Edinb. Phil. Journ. 12, 1825, p. 81.
THOMSON: Outlines of Mineralogy, 1, 1836, p. 427.
MILLER: Phil. Mag. 16, 1840, p. 477.
RAMMELSBERG: Pogg. Ann. 63, 1844, p. 142.
SVANBERG: Öfvers. K. Vet.-Akad. Förh. 2, 1845, p. 37.
DAMOUR: Compt. rend. 43, 1856, p. 1197.
DESCLOIZEAUX: Ann. des mines, 11, 1857, p. 270.
DESCLOIZEAUX: Manuel de Minéralogie, 1, 1862, p. 160.
v. LANG: Phil. mag. 25, 4. Ser. 1863, p. 436.
NYLANDER: Acta Universitatis Lundensis, 1864, II, Nr. 2.
DANA: System of Mineralogy, 1868, p. 248.
v. KOKSCHAROV: Russ. min. Ges. 1878, p. 205. — Mat. zur. Min. Russlands, 8, 1878, p. 29.
LORENZEN: M. o. G. 2, 1881, p. 63.
RAMMELSBERG: Sitzungsber. d. k. Preus. Akad. d. Wiss. zu Berlin, 1886, p. 441.
RØRDAM: M. o. G. 7, 1893, p. 49.
ROSENBUSCH: Mikroskopische Physiographie, 1, 1892, p. 423. (investigations by WÜLFING).
USSING: M. o. G. 14, 1898, p. 145.
STEENSTRUP: M. o. G. 34, 1910, p. 132.

Found in very large quantities as a constituent of nepheline-syenite (often more than 10 % of the rock) and in many pegmatite veins in

the latter; many veins are very rich in e., and in many places there may be found continuous layers of up to 1 m thick, consisting of nearly pure e. In the pegmatite veins e. is found mixed with felspar, arfvedsonite and other minerals, and it is most frequently crystallized before the greater part of the latter, for which reason it often has a well-developed crystal form. The size of the crystals varies from nearly microscopical to about 10 cm. The form is generally octahedral, like that of the crystals from Narssârssuk, but they are most frequently somewhat richer in faces. The faces are often rather dull, but sometimes they are also bright, as the brown variety from Naujakasik.

In colour e. from certain rocks may be intensively red, as is the case in the kakortokites, but from the pegmatite veins it is generally of an impure greyish red colour; in an area at Tunugdliarfik, particularly at Naujakasik, where very many and well-developed crystals have been found, the colour is dark-reddish brown. The pleochroism differs very much, but ω is always slightly more vivid in colour than ε. As a rule e. does not enclose foreign minerals, but large parts, particularly of the brown crystals, are densely packed with microscopical interpositions of an unknown nature.

The strength of the birefringence varies greatly; Ussing determines $\varepsilon - \omega$ at 0.0026 and 0.0037, whereas Wülfing has 0.0018. The inhomogeneity is sometimes original and appears either as a zonary structure, layers with a varying positive birefringence interchanging with each other, or as an hour-glass structure, the crystals being divided into departments, which are generally positive but sometimes also isotropic or even negative. Along fissures secondary irregularities are sometimes found, as the substance also in such places may have been isotropic or negative.

The optical properties of the eudialyte when heated undergo very peculiar changes, as has been proved by Ussing. When heated to a temperature very near 400°, but not to ignition, the birefringence decreases greatly, but increases again when it is being cooled, so that it is even stronger after this process than before. When heated to faint ignition, the birefringence decreases strongly and does not increase again during the cooling process. When heated to a stronger ignition with the succeeding cooling the crystals become violet and opaque and negatively birefringent, and when heated to a very high temperature the colour after cooling changes into a pale brownish red, and the birefringence once more becomes positive.

The specific gravity is determined at 2.906 (Damour), 2.85 (Lorenzen), 2.928 (Rammelsberg). Analyses have been undertaken by Stromeyer (1), Pfaff (2), Rammelsberg (3), Damour (4), Nylander (5), Lorenzen (6) and Rammelsberg (7—11).

	1	2	3	4	5
SiO_2	52.48	54.10	49.92	50.38	51.86
ZrO_2	10.90	11.58	16.88	15.60	14.67
Ce_2O_3	—	—	—	—	—
Ta_2O_5	—	—	—	0.35	—
Fe_2O_3	6.86	7.86	—	—	—
FeO	—	—	6.97	6.37	6.54
Mn_2O_3	2.57	2.93	—	—	—
MnO	—	—	1.15	1.61	1.46
CaO	10.14	10.80	11.11	9.23	9.82
MgO	—	—	—	—	—
CuO	—	0.92	—	—	—
Na_2O	13.92	11.40	12.28	13.10	12.32
K_2O	—	—	0.65	—	—
Cl	1.03	0.30	1.19	1.48	1.37
Loss by ignit.	1.80	1.66	0.37	1.25	1.43
	99.70	101.55	100.52	99.37	99.47

	6	7	8	9	10	11
SiO_2	48.63	49.37	49.84	50.09	49.86	49.62
ZrO_2	14.49	15.09	14.01	14.05	14.28	14.12
Ce_2O_3	2.27		2.35	2.49	2.60	2.50
Ta_2O_5	—	—	—	—	—	—
Fe_2O_3	—	—	—	—	—	—
FeO	5.54	6.58	5.96	6.34	5.12	7.16
Mn_2O_3	—	—	—	—	—	—
MnO	0.42	1.12	0.64	0.75	1.14	1.34
CaO	10.57	10.83	10.77	10.30	11.02	9.66
MgO	0.15	—	—	—	—	—
CuO	—	—	—	—	—	—
Na_2O	15.90	12.83	13.32	13.53	13.76	13.24
K_2O	trace	0.66	0.75	0.44		
Cl	1.04	1.53	—	—	—	1.36
Loss by ignit.	1.91	1.24	—	—	1.24	—
	100.92	99.25	97.64	97.99	99.02	99.00

The eudialyte from Kangerdluarssuk frequently proves quite altered; Ussing distinguishes between three kinds of pseudomorphs, some with catapleiite preponderating and some with zircon. The former is found in eudialyte foyaite from Kumerngit; here also microcline occurs, the individuals of which are directly connected with microcline individuals outside the pseudomorphs; further some analcite occurs. The second kind is found in foyaite, rich in eudialyte from Kangerdluarssuk; here acmite and smaller quantities of fluorite and zeolites occur. The third kind, from the lujavrites, chiefly contains analcite and possibly also an unknown mineral, related to pectolite. The zircon-bearing pseudomorphs, which are of greyish brown colour and a nearly earthy appearance, also contain felspar, zeolites and acmite.

After the investigations undertaken by Ussing Flink brought home a couple of crystals from Kangerdluarssuk, which quite resemble the crystals described from Narssârssuk, as they chiefly consist of elpidite and ægirine; possibly it is a question of localities having been exchanged.

Whereas the hitherto mentioned pseudomorphs contained some zircon-bearing mineral or other, this is not the case with a few small crystals found in 1900 near Redekammen (ɔ: the comb) at the head of Kangerdluarssuk. The crystals which are found in cavities in microcline have, it is true, quite dull faces, but the form is very distinctly the same as eudialyte. The colour is greyish green and on fractures variegated white and green. Under the microscope a fine-grained structure with epidote and plagioclase is visible, so that smaller individuals of the former are poikilitically grown into the plagioclase, which judging from the refraction seems to be an albite-oligoclase.

Kangerdluarssuk is the first place in the world from which this mineral is known. As regards the first mention of it opinions vary rather much; it is mostly said that the first to mention it were Tromsdorff (1801) and Gruner (1803), but as to this the reader is referred to the mention of garnet from Auvaitsersarfik (p. 199); with certainty no mineral from Kangerdluarssuk was known before the time of Giesecke's travels. Giesecke decribes e. as red garnet, and Allan mentions it as a garnet of an otherwise entirely unknown form i. e. an octahedron, blunted at all angles and edges. The same form is described by Stromeyer, who for the first time analyses the mineral and gives it a name referring to its readiness to dissolve. Hauy states that its crystal form is the dodecahedron, but it would seem difficult to make this form agree with that of the eudialyte. Phillips regards the mineral as hexagonal and Mohs as rhombohedral, and on later occasions the various crystal forms have been described by several investigators, whereas more particularly Ussing has examined the physical properties.

As the eudialyte occurrences represent a larger accumulation of the element zirconium, than is otherwise usually the case, attention has long been directed towards the use of e. in case of a subsequent greater technical application of zirconium. Rørdam proposes that it should be possible to use it for the lime-light of Drummond, but nothing more has been heard about it. Steenstrup has twice collected larger quantities of material for the "Kryolith Mine- og Handelsselskabet" i. e. in 1888, about 15.000, and in 1899, about 44.000 kg. "Øresunds Chemiske Fabriker" worked up this material in eudialyte, hornblende and sodalite; the latter was used at glass-works, but up to the present no independent use has been found for the eudialyte.

Outside Greenland e. has by and by been found in a number of different localities, more particularly Langesunds Fjord in Norway and the peninsula of Kola; as far as can be seen from the existing literature, it is in this locality found in much greater quantities than in Greenland.

In connection with e. must be mentioned a mineral from Kangerdluarssuk, which has been described by Ussing (Geol. Fören. Förh. Stockholm, 10, 1888, p. 190) and is probably closely related to or even identical with e.; the crystals are rhombohedral with forms and axial values agreeing with those of the eudialyte. Translucent, brilliant, yellowish brown without pleochroism, birefringence positive. Hardness 5; specific gravity 2.970. Found as small crystals (4 mm) grown into microcline, together with ægirine and polylithionite.

Qeqertarssurssuaq, one of the Kitsigsut Islands (possibly identical with Qeqertârssugssuk south of Nanortalik) (Laube).

Laube: Sitzb. d. k. k. Akad. d. Wiss. Wien, 68, 1873, p. 85.

Vrba: ibid. 89, 1874, p. 101.

Jessen: M. o. G. 16, 1896, p. 146.

Small crystals (a few mm) of a blood-red or brownish red colour, grown into hornblende. Measurings of crystals and specific gravity (2.841) decidedly point towards e. Jessen states that he has not been able to find eudialyte-syenite on any of the Kitsigsut Islands, for which reason he is of the opinion that the sample must originate from a loose block.

136. Catapleiite. $Na_2Zr[Si_3O_9]H_2O$.

The Julianehaab district.

Narssârssuk (Lützen's collection 1893).

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 206. — Zts. f. Kryst. 23, 1894, p. 359.

Flink: M. o. G. 14, 1898, pp. 232, 235 and 250.

Flink: M. o. G. 24, 1901, p. 93.

Bøggild: M. o. G. 33, 1907, p. 106.

Gordon: Proc. Acad. Nat. Sci. Phil. 76, 1924, p. 249.

With the exception of some of the crystals which have been described by Gordon, but which possibly are not of c. and will be mentioned below, all Greenland crystals of c. like the Norwegian one, have a pronouncedly hexagonal form which, when optically investigated, proves to be polysynthetically composed of lamellæ of rhombic or monoclinic symmetry. When the mineral is heated, all the lamellæ disappear but reappear when it is cooled. The crystals are tabular, parallel with the base and at the edge bounded by a prism and one or more pyramids; very faint prismatic cleavage (in the Norwegian soda-catapleiite frequently a rather perfect cleavage is reported). Very intricate twin

formations are described by FLINK. Hardness 6; specific gravity 2.78—2.74. The acute bisectrix is at right angles with the hexagonal base; the axial angle (2 V) is measured at 30°—40′ (in the Norwegian material 60°). The indices of refraction are determined by the author: $\alpha = 1.5905$, $\beta = 1.5921$, $\gamma = 1.6269$, of which $2\,E = 41°1'$, the crystal thus being positive. The form of the hexagonal higher temperature is uniaxial, positive.

FLINK distinguishes between three types to which has been added a fourth, established by the author. The most characteristic external properties are the following:

Type 1. Bounded by $(10\bar{1}0)$ and $(10\bar{1}3)$; the base is very shining, the other faces quite uneven and dull. The crystals are rather clear and transparent, mostly of a yellowish colour. They may become rather large (width up to 5, thickness up to 1 cm), and they have been found in very large quantities, most frequently unassociated with other minerals.

Type 2. Bounded by $(10\bar{1}2)$ and $(10\bar{1}1)$, rarely $(10\bar{1}0)$; the faces all shining and strongly iridescent with different colours. The crystals very small (up to 3 mm) and not very numerous; they are to be found scattered on the walls of cavities. By FLINK (1898) called "catapleiite-like plates".

Type 3. Bounded by $(10\bar{1}0)$, $(10\bar{1}3)$, $(10\bar{1}2)$, $(10\bar{1}1)$, $(20\bar{2}1)$; the faces are well-developed and shining; colourless, frequently with a faint iridescence. The crystals small (up to 5 mm), but they sometimes occur in a very large number together with orthoclase, ægirine, elpidite and rhodochrosite. FLINK (1898) names them "hexagonal plates".

Type 4. Very small crystals (up to 1 mm) with $(10\bar{1}3)$ as the only marginal face; found in cavities in orthoclase and ægirine, originally only in a single specimen; however, GORDON later on reports having found new material.

The above-mentioned types are not only different in habits, but also in their physical properties; they show very characteristic differences, more particularly in two respects:

1. The temperature of inversion is for type 1: 110°—130°, for type 2: 160°—230°; type 3 is inverted by 8°—40°; type 4 lacks for the greater part twin-lamellæ; if present, they disappear at about 50°.

2. As mentioned most crystals of c. are rhombic or monoclinic at an ordinary temperature; whether the one or the other it seems rather impossible to determine. The lamellæ pass in various directions, which form angles of 30° and 60° with each other, but one thing is very peculiar; the optical axial planes lie in three different directions which in the crystals of type 1 are always at right angles with the prismal faces; that is the outline of the crystal, whereas in the three other types they

are parallel with these directions. That these differences are not due to differences in the chemical composition appears, however, from types 1 and 3, the only ones of which sufficient material could be provided; both analyses were undertaken by FLINK (in the treatise from 1893 and 1901).

	Type 1	Type 3
SiO_2	44.08	44.70
Zr_2O_3	31.83	30.85
CaO	0.17	0.71
Na_2O	14.80	14.09
H_2O	(9.12)	9.07
	100.00	99.42

This composition agrees very well with the formula of the mineral given above. In Norway, where c. was first known, Na was in most cases largely replaced by Ca. In more recent times c. has also been found in Arkansas.

GORDON has found some crystals, several millimetres large, at Narssârssuk they are completely rhombic as to habits and not the least bit hexagonal. He calls the mineral α-catapleiite and is of the opinion that it is formed, while the temperature was below that of the inversion point. The angles measured, and so also the axial ratios agree very well with those of c., but in other respects there is very little agreement. Specific gravity 2.658, a good deal less than usual; refraction $\alpha = 1.575$, $\beta = 1.590$, $\gamma = 1.605$. The axial angle must consequently be very nearly 90°, and it is not easy to see, how GORDON has come to determine the mineral as optically negative. The great deviation from other occurrences of c. in the optical properties makes it rather doubtful, whether the mineral belongs here.

The region of Kangerdluarssuk (STEENSTRUP 1888).

USSING: M. o. G. 14, 1898, p. 164.

Very common as a transformation product of eudialyte in the medium- or fine-grained nepheline-syenites, together with felspar, ægirine, zeolites, fluorite, mica and other minerals. Irregularly hexagonal tables (0.01—0.1 mm) optically uniaxial, by preference orientated parallel with (0001) of the eudialyte. As to the details of the nature of the pseudomorphs see the description of eudialyte.

137. Chrysocolla. $CuSiO_3 \cdot nH_2O$.

The Godthaab district.

Ivnajuagtoq in Godthaab Fjord (HELWEG 1913). Thin crusts (0.1—0.2 mm) on quartzite. The surface uneven; the colour vividly green. The substance optically isotropic as opposed to what is generally the case with this mineral; but all other properties agree completely.

The reactions are sure, both for copper, water and silica, and it also gelatinizes with acids. The refraction is about 1.58, but it is difficult to measure it, as the substance is rather opaque. Various colloidal forms of c. are known, such as cornuite, katangite and traversoite, which can hardly be regarded as independent minerals, and it is not possible to determine with certainty whether the mineral in question is identified with any of them.

The Frederikshaab district.

Avigait, west of (NYEBOE 1915). The occurrence is very similar to the preceding one; on gneiss very thin crusts are found of a more impure green colour. Also this substance is isotropic.

138. Neptunite. $Na_2FeTi[Si_4O_{12}]$.

The Julianehaab district.

Narssârssuk (LÜTZEN's collection 1893).

FLINK: Geol. Fören. Förh. Stockholm, 15, 1893, p. 196.

SJÖSTRÖM: ibid. p. 393.

G. NORDENSKJÖLD: ibid. 16, 1894, p. 346.

FLINK: Zeits. f. Kryst. 23, 1894, p. 346.

FLINK: M. o. G. 14, 1898, p. 232.

FLINK: M. o. G. 24, 1901, p. 120.

WALLENSTRÖM: Geol. Fören. Förh. Stockholm, 27, 1905, p. 149.

BØGGILD: M. o. G. 33, 1907, p. 119.

Crystallization monoclinic; the habits of the crystals will best appear from a consideration of the two, mutually rather different main types; viz. FLINK's types 1 and 2, on which there are the following faces: *a* (100), *b* (010), *c* (001), *m* (110), *d* ($\bar{3}01$), *e* ($\bar{2}01$), *s* (111), *v* (221), *o* ($\bar{1}11$), *u* ($\bar{5}12$), *p* ($\bar{3}11$), *q* ($\bar{7}12$). Sometimes twins with a twin plane (001). Distinct cleavage parallel with (110), conchoidal fracture. Hardness 5—6; specific gravity 3.234. The colour black, only in thin splinters deeply blood-red; the streak brown. Optically positive. The axial plane at right angles with (010). The acute bisectrix forms an angle of + 18° with the *c*-axis. Difference in absorption c > b > a. Analyses undertaken by FLINK (1) and SJÖSTRÖM (2):

	1	2
SiO_2	51.53	51.93
TiO_2	18.13	17.45
FeO	10.91	10.23
MnO	4.97	5.32
MgO	0.49	—
CaO	—	0.71
K_2O	4.88	5.71
Na_2O	9.26	9.63
	100.17	100.98

This composition very nearly corresponds with the formula (Fe, Mn), $(Na, K)_2 (Si, Ti)_5O_{12}$, where Fe:Mn = 2:1, Na:K = 3:1, Si:Ti = 4:1. The mineral resembles titanite, both as regards composition and crystal form.

Before the blow-pipe n. easily melts into a black mass; it is not dissolved by acids.

Upon the whole 5 types have been described; of these type 1 has been found in rather large crystals (up to 5 cm) of the form shown in

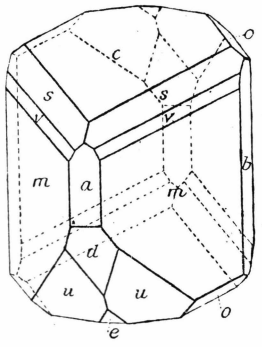


Fig. 52. Neptunite. Narssârssuk (Type 1). (After Flink).

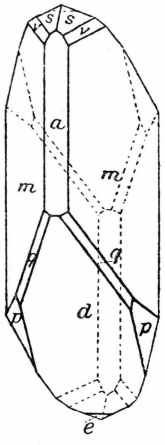


Fig. 53. Neptunite. Narssârssuk (Type 2). (After Flink).

fig. 52. The faces are very different of character; *c* is always shining and *b* rather dull; *m* is glossy, but vertically striated. Twins are very rare. The crystals are generally found grown on to larger individuals of quartz, felspar or ægirine, and as a younger generation are found various other of the minerals characteristic of the locality. In Lützen's collection there were a number of fairly large crystals, and a great deal more have been collected in the course of Flink's travel, but the occurrence seems now to be exhausted.

Type 2 (fig. 53) consists of prismatic crystals, up to 2 cm long. Of the principal faces *m* is well-developed, faintly striated in two directions, *d* is rather uneven grooved, *a* is vertically striated; the other faces are shining. Twins are extremely rare. Like the preceding type this one has also only been found in one of the secondary localities, but in greater quantities and frequently with numerous closely packed crystals. Since Flink's travel no more material has been produced, and so also this occurrence must be supposed to be exhausted.

Type 3 consists of small (3—4 mm) crystals, which abound very much in faces, and have only been found in small amounts. The total form bears the greatest resemblance to type 1.

Type 4 has been described by WALLENSTRÖM; it consists of small (about 5 mm) prismatic crystals, which chiefly deviate from type 2 by *e* ($\bar{2}01$) being the dominant face among the terminal ones.

Type 5 has been described by the author; the crystals which are rather large (about 2 cm) originate like the preceding one from the BERNBURG collections. They are particularly distinguished by the very marked form *c* (001) and by the fact that twin formations and the resulting parting are very common.

The mineral was first named neptunite by FLINK after Neptune, as an analogy of ægirine which was called after the deity of the northern seas. The mineral has later on been found in two localities in the Kangerdluarssuk area, which will be mentioned in the following; furthermore, in rather large quantities in California. A mineral, manganneptunite from Kola, is in all respects identical with n., with the exception that the quantity of Mn is greater than that of the iron.

The region of Kangerdluarssuk.

GORDON: Proc. Acad. Sci. Nat. Sci. Phil. 76, 1924, p. 251.

At Tugtup agtakôrfia FLINK has collected a sample with crystals of n., found in a mixture of analcite and polylithionite and also an unknown yellow mineral. N. which on all sides is enclosed in the minerals mentioned above, has individuals of about 2 cm in size, and it is only in part bounded by plane faces (110), (001) and (100); repeated twin formation. The crystals are composed of hypoparallel individuals, arranged fanwise. In the neighbouring locality, Tuperssuatsiaq, a specimen has been found, as it seems collected on an earlier occasion; it agrees essentially with the preceding one, but is interesting as it contains large quantities of sodalite, which makes it quite sure that it belongs to the region of Kangerdluarssuk.

From Igdlunguaq GORDON describes a single specimen of n, $1 \times 0.5 \times 0.5$ mm in dimensions and embedded in an analcitized arfvedsonite-lujavrite. As this locality is situated in the neighbourhood of the two immediately preceding ones, the occurrences may possibly be identical.

139. Igalikite. $KNaAl_4[Si_4O_{15}] \cdot 2H_2O$.

The Julianehaab district.

Igaliko, about 35 km east of (ØDUM 1927).

ØDUM: M. o. G. 74, 1930, p. 46.

BØGGILD: M. o. G. 92, 9, 1933.

The mineral consists of an aphanitic aggregate which at first sight seems very uninteresting, but when viewed in sharp one-sided light and in the goniometer gives a distinct though faint reflection of light

in four directions, orientated as a hexagonal prism with the base. In thin sections the mineral upon the whole shows a very irregular structure, but a great number of plate-shaped particles stand out, being in the main parallel with the four above-mentioned directions, even though many of them are irregularly orientated. The individuals are optically uniaxial, and we are thus dealing with a substance which is either tetragonal or hexagonal; this is, it seems, rather unique, and it is not possible to decide to which of the two systems the plates belong.

The colour is light-reddish, greyish or yellowish, the substance dull and opaque; hardness $5^1/_2$ and specific gravity 2.568. The average refraction is about 1.540; the birefringence almost as in quartz, but none of the values mentioned can be accurate, as the substance is surely mixed up with products of all possible degrees of alteration. Before the blow-pipe it melts easily, and it is dissolved by acids while gelatinizing. Analysis made by Chr. Detlefsen: SiO_2 45.85, Al_2O_3 32.60, Fe_2O_3 0.92, CaO 1.41, MgO 0.15, K_2O 6.29, Na_2O 5.92, H_2O 6.80 = 99.94. This corresponds fairly well with the formula $NaKAl_4Si_4O_{15}$, $2H_2O$.

The material consists of a single loose block weighing about 50 g; possibly a geode, it has been found in a nepheline-syenite area, and the minerals accompanying it are not characteristic of this species of rock, but of the augite-syenite, which is found to the west of the nepheline-syenite in this region and may possibly also be found to the east of the latter. The minerals are barkevikite, green augite, felspar, mostly orthoclase-perthite and, in smaller amounts, biotite, magnetite, apatite and olivine. The above-mentioned minerals have partly their own crystal-form, but partly also irregular boundaries towards the igalikite.

140. Beryl. $Al_2Be_3[Si_6O_{18}]$.

The Godthaab district.

Eqalúnguit (Sørensen, physician, 1874).

Lorenzen: M. o. G. 1, 1879, p. 86.

Found together with tourmaline in a 5—8 dm thick pegmatite vein, the main constituents of which are oligoclase and quartz. The crystals attain up to 13 cm in height and width and may weigh up to 5 kg. Bounded by $(10\bar{1}0)$ with secondary $(21\bar{3}0)$. The faces imperfectly developed, dull; the central parts of the crystals very impure with quartz and muscovite grown into them. Semi-transparent, of an impure greenish, sometimes brownish or bluish tinge.

Qasigiánguit at Godthaab (Giesecke).

Giesecke: Catalogue of Minerals p. 211.

From here emerald is reported in rounded blocks; curiously enough no traces of this rather conspicuous mineral have been found since then.

Qarajat (FÆSTER 1927). Small crystals (up to 8 mm) found in granular quartz with biotite; only a suggestion of crystal-bounding $(10\bar{1}0)$, the colour green.

The Julianehaab district.

Niaqornârssuk (GIESECKE 2-9-1806). Here "schörlartiger Beryll" is mentioned together with hornblende (ægirine), calcite, felspar, apophyllite and other minerals in granite. The mineral is not found in GIESECKE's collections, and possibly it has been mistaken for apatite, which GIESECKE collected in this place. When RINK[1]) mentions that GIESECKE reports the occurrence of beryl from Kangerdluarssuk, it seems to be due to the two localities having been mistaken for each other.

Julianehaab (NYEBOE 1915). On the label the place of occurrence is given as "Nær sort Top" (ɔ: near black peak). There is only a single fragment of a crystal (about 16 mm) in quartz; the only developed face is $(10\bar{1}0)$. The colour greenish-white.

Sârdloq, Igdlorpait and Uvkusik (TAYLER 1856).

TAYLER: App. to Giesecke's Catalogue of Minerals, p. 215.

JESSEN: M. o. G. 16, 1896, p. 125.

Crystallized together with fergusonite in granite-pegmatite. Only form $(10\bar{1}0)$; frequently very incomplete and uneven; distinct faces often lacking. The crystals are often intergrown with the minerals of the pegmatite. Rather opaque; the colour sometimes rather pure light-blue, most frequently a faint greenish- or greyish blue.

East Greenland.

Tunua, island in the northern part of (EBERLIN 1885). Fragment of a crystal (6 mm) $(10\bar{1}0)$ with well-developed, shining faces. Semi-transparent of an impure greenish white colour.

Karra Akungnak (EBERLIN 1885).

EBERLIN: M. o. G. 9, 1889, p. 255.

Crystallized in coarse-grained pegmatite quartz; the length of the crystals up to 8 cm. The crystals are always broken and frequently traversed by faults. $(10\bar{1}0)$ and sometimes $(11\bar{2}0)$ with well-developed, regular, rather dull faces. Opaque. The colour a rather pure light-blue, sometimes with a somewhat greyish tinge.

Greenland without a definite locality.

ROBERT: Bull. Soc. Géol. de France, 12, 1841, p. 369.

ROBERT reports having received beryl from Greenland, as a present from Senator BINGER in Hamburg; as minerals, which are otherwise not known to occur in Greenland, are mentioned in the same place, their origin must be regarded as extremely doubtful.

[1]) RINK: Gr. II, App. 147.

141. Iolite. $Mg_2Al_3[AlSi_5O_{18}]$.

The Thule district.

Polaris Havn.

Fielden: Geol. Mag. New. Ser. 2, 1895, p. 379.

Reported to be found as a constituent of a boulder, probably a "garnetiferous cordierite-fibrolite-gneiss" (cfr. what is said under garnet).

The Upernavik district.

Uigordlerssuaq (Giesecke 23-7-1807). The most considerable occurrence in Greenland. The mineral is found as crystals (up to 8 cm) in pegmatite. The crystals are rather irregular and skeletal; observed faces are *a* (100), *m* (110), *d* (130), *b* (010), *c* (001) and *n* (011), the latter very indistinct, the other forms have plane though somewhat dull faces. This has some bearing upon the fact that the outer parts are always altered. The specific gravity of the fresh mineral 2.597. Pleochroism the usual one. The altered parts which Johnstrup (in Giesecke) names praseolite are of a dark greenish grey colour and rather opaque; under the microscope they prove to consist of a very fine-grained aggregate, which with irregular boundaries are mixed with the fresh mineral. The refraction is about 1.58; it is possibly a mica-like mineral.

Erqordleq (F. Johansen 1932). Some small (diameter up to 3 cm) samples unconnected with other minerals excepting a few very small quartz particles. The form quite irregular, the blue colour and the pleochroism very striking.

Arfitsiaq (Giesecke 17-7-1807). The mineral reported from this locality resembles talc and is presumably an altered iolite, even though the crystal form is not distinct. Its outward appearance is exactly like the one from Uigordlerssuaq; under the microscope it proves to consist of a skeleton of strongly birefringent figures with complete extinction which, it seems, is due to the fact that all the mica leaves have the same orientation. In the interstices there is a nearly isotropical substance.

Langø (Rink).

Rink: Ngr. p. 42.

Found together with felspar and quartz in the shape of irregularly bounded, completely fresh grains in the veins rich in garnets. Further, similar altered masses, which have been mentioned above, are found in a graphic granitic mass, with very small quantities of graphite; there are very faint traces of the crystal form of the iolite.

The Ritenbenk district.

Asuk.

Nicolau: M. o. G. 24, 1901, p. 239.

In the iron-bearing rock a few crystals (up to 16 mm) are to be

found, being of a brown colour and a faint greasy lustre. Various properties, such as the specific gravity 2.612, the partial solubility in hydrochloric acid, and the contents of Al_2O_3 in the solution might point towards the mineral being iolite. In thin sections it proves, however, to consist of an aggregate of quartz grains, cemented together by a brownish yellow isotropic substance.

The Christianshaab district.

Isua (Giesecke). Irregularly shaped masses in pegmatite; the colour bluish.

Nûk (Fæster 1939). Fairly large crystals (up to 8 cm in diameter) in pegmatite; the adjacent rock rather seems to be gneiss. The crystals, it is true, seem generally to be bounded by plane faces, but it is impossible to extract them unbroken, so as to be able to determine the crystal form. The substance in most cases is unusually pure and clear, of a beautiful bluish colour, but under the microscope it is seen that small quantities of mica are segregated in small fissures, and it is also possible to find a few crystals, entirely altered to mica; the mica leaves have an irregular orientation.

Whether this locality is identical with the preceding one, it is impossible to say; the distance between the localities is not great, and there is no essential difference between the rocks.

The Godthaab district.

Qasigiánguit at G. (Giesecke 3-7-1810).

Leonhard: Handwörterbuch d. topogr. Mineralogie 1843, p. 40.

Haidinger: Pogg. Ann. 67, 1846, p. 446.

Crystallized (2—20 mm) in pegmatite. Combination: *a* (100), *b* (010), *m* (110), *d* (130), *c* (001), rarely *n* (011). The faces uneven and dull. The iolite is everywhere rather decomposed; only in the interiors of the crystals there are parts of fairly pure, blue colour; otherwise they are dark-grey, without pleochroism, and the outer parts are greyish, soft. In other samples from the same occurrence there are exclusively altered crystals of a substance resembling talc. Sometimes the crystals are hexagonal, which might point towards their being the usual pseudomorphs after iolite. It is possibly this mineral, which Giesecke describes as apple-green hexagonal complete prisms.

Auvaitsersarfik (Giesecke 1-6-1810).

Leonhard: Handwörterbuch d. topogr. Mineralogie, 1843, p. 140.

Mentioned by Giesecke as a sapphire-blue mineral merging into amethyst and containing four-sided, white prisms. From that and the preceding locality Leonhard mentions iolite together with garnets and black mica in granite.

Simiutat (Giesecke).

Stromeyer: Göttingische gelehrte Anzeigen, 1819, p. 1993.

Haidinger: Abh. d. k. böhm. Gesell. d. Wiss. V. Folge, 4, 1845, p. 3. — Pogg. Annal. 67, 1846, p. 441.

Rosenbusch: Mikroskopische Physiographie, 1, 1873, p. 273.

As to the occurrence nothing is known. The colour is described by Stromeyer as resembling that from the occurrence Bodenmais in Bavaria, but more bluish-grey. According to Haidinger the colour is black ash-grey with the following shades: a faintly bluish, b neutral, c smoke-grey; according to Rosenbusch it is: a reddish brown with a honey-coloured tinge, b dark leather-brown, c smoke-coloured, brownish. According to Stromeyer the specific gravity is 2.5995. Analysis undertaken by Stromeyer: SiO_2 49.1700, Al_2O_3 33.1055, MgO 11.4800, FeO 4.3380, MnO tr., H_2O 1.2042 = 99.2977.

The Julianehaab district.

Sermersôq (Eberlin 1884, Fæster 1916).

Eberlin: M. o. G. 9, 1889, p. 251.

Somewhat different occurrences are reported. Eberlin mentions Kangeq which is the southern point of Sormersôq; Fæster partly mentions the island Siorartússoq south of this promontory, partly the east coast of Sermersôq. The material from all of these occurrences consists of irregularly shaped grains of a rather fresh consistency in pegmatitic rocks or gneiss. Eberlin also reports having found i. on some small islands, south-east of Nanortalik.

East Greenland.

Kangerajuk or Kap Huitfeldt (Eberlin 1884).

Eberlin: M. o. G. 9, 1889, p. 251.

Found in rather large quantities in gneiss together with garnet as irregularly shaped grains. It is probably this mineral which Laube describes as sapphire (for details see corundum).

142. Vesuvianite. $Ca_{10}(Mg,Fe)_2Al_4[(OH)_4(SiO_4)_5(Si_2O_7)_2]$.

The Godhavn district.

Hvalfiske Eilander (Rink).

Fragment of a single crystal (15 mm) without other minerals. Only prism faces are found, viz. (100) and (110), the one very narrow. The faces very regular and shining, not the least striated. Pale green, rather transparent.

The Egedesminde district.

Manîtsoq (Rink).

Rink: Ngr. p. 41.

Found as a vein-like filling, about 0.5 m thick, in dolomite. V. forms aggregates, the sizes of the individuals being up to 1 dm, partly together with oligoclase and calcite. On the boundary towards this mineral there are always well-developed faces, and frequently also the prism faces are visible in the interior parts of the individual. The individuals are very irregularly developed, as if they were composed of a number of smaller ones with an almost parallel orientation. The prism faces most marked, *a* (100) and *m* (110) nearly equally large, *f* (210) rather narrow. The prismal zone greatly striated. Terminal faces were only found in a few cases; *c* (001) with smaller faces of *p* (111) and *t* (331). The faces rather well-developed and shining, the colour greyish brown.

The Godthaab district.

Godthaab (Sørensen 1874). Crystallize together with garnet, quartz and felspar. The form very irregular, only the prismatic zone developed with an extremely strong striation. The colour dark brownish green.

143. Prehnite. $Ca_2Al_2[(OH)_2Si_3O_{13}\cdot]$.

The Upernavik district.

Prøven. Crust-shaped formation without any rock attached to it; about 1 cm thick. A good deal of rock-crystals are found on p. The surface is uneven, with very indistinct lenses of projecting crystals. The colour greenish grey.

The Umanak district.

Qeqertarssuaq (Peter Davidsen). Between Naujât and Tuperssúartâ were found on the beach enormous masses of p., and this occurrence is by far the most conciderable in Greenland. The mineral originates from basalt, but in the samples collected there is no rock left. They form thick and solid crusts on the surface of which there are rounded protrusions with a diameter of 1—3 cm; their surface may be qûite plane, but in other instances crystals (c. 1 mm) are developed. The crystal form is not very easily determined because of the curved and striated faces, but it seems to be a combination of (110) and (001) with smaller faces of (010). The colour is a fine light-green.

Niaqornat (Giesecke 1811). Greyish balls (about 5 mm) in tuff; the surface rather smooth, nearly without a trace of crystals.

The Ritenbenk district.

Klokkerhuk (Steenstrup 1872). Small crystals (1—2 mm) in a fissure in gneiss; the faces indefinable. The crystals built up of numerous hypoparallel individuals. The colour light-bluish green.

The Godhavn district.

Fortunebay (O. R. B. Hansen 1937). Radiating aggregates together with calcite, quartz and a little epidote. In cavities crystals (up to 3 mm), flattened parallel with (001) and otherwise bounded by (100), (010) and (110). The faces dull, and upon the whole imperfectly developed; the colour whitish or greyish.

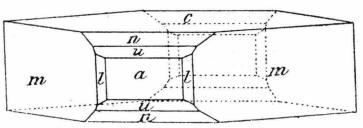


Fig. 54. Prehnite. Josva's Copper Mine.

The Julianehaab district.

Josva's Copper Mine (Hoff 1863). Crystallized on fissures in a greenish, fine-grained rock, chiefly consisting of actinolite. The cavities partly filled with calcite. The crystals as a rule well-developed, as shown on fig. 54. The following faces have been observed: *a* (100), *c* (001), *m* (110), *l* (410), *u* (301), *n* (302), *v* (304).

a and the faces nearest it are as a rule extremely shining, the others, on the other hand, dull and striated; *l* and *u* are always shining and are to be found on most crystals, but they are very narrow. *m* is always large and shining in the front part, but at the back it is very uneven, *n* is often, and *c* always highly striated parallel with the *b*-axis.

Most frequently numerous crystals are placed together in a hypoparallel position with a common *b*-axis. The crystals are 1—2 mm in size; they are faintly greenish, transparent.

The region of Kangerdluarssuk (Giesecke 3-9-1806).

Flink: M. o. G. 14, 1898, p. 247.

The mineral has been found in various places in the nepheline-syenite. When Flink mentions p. from Nunarssuatsiaq, it has later proved to be apatite; on the other hand at Nunasarnaq, also on the northern side of Tunugdliarfik, Giesecke has collected p. in foliated and radiating pale-green masses, which together with epidote form veins in diabase. At Siorarssuit (probably on the southern side of the same fjord) Steenstrup has collected small, colourless crystals together with ægirine etc. At Kangerdluarssuk Ussing has found

prehnite in the area between Niaqornârssuk and the island of Qeqertaussaq, the shape being the usual crust-like foliated masses of a greyish green colour, together with small, reddish albite crystals. A fragment of crust-like prehnite, found at Nunasarnaussaq, originates from ancient times.

East-Greenland.

Milne Land (The three Year's Expedition 1933). In a loose block consisting of a very strongly altered basaltic rock, a geode was found, one side of which was filled with p. the other with calcite. The boundary between the minerals was, as far as could be seen, quite irregular. P. the longitudinal extent of which is about 5 cm, is of a pure light-green colour; under the microscope it proves to consist of quite small individuals, penetrated with intricate systems of twin lamellæ, at least in certain parts.

144. Leucosphenite. $Na_4BaTi_2[Si_{10}O_{27}]$.

The Julianehaab district.

Narssârssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 236.

Flink: M. o. G. 24, 1901, p. 137.

Crystallizes in the monoclinic system, generally in a form shown on fig. 55 with the faces *c* (001), *b* (010), *m* (110), *n* (130), *d* (101), *x* (011); a few other forms may occur. Twins with twin plane (001) are

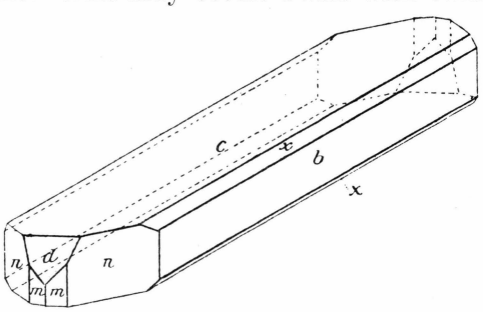


Fig. 55. Leucosphenite. Narssârssuk. (After Flink).

rather common. The crystals are fairly homogeneous, *c*, *b* and *n* being the prevailing faces; all the other forms are small. The crystals are always elongated in the direction of the *a*-axis. The crystals are small, up to 5 mm in length; they are most frequently developed at both ends. The faces of *c* are strongly striated in the direction of the *a*-axis; *b* and *n* are vertically striated, the other faces rather shining.

Distinct cleavage parallel with *b*; hardness $6^1/_2$. The lustre is vitreous with pearly lustre on *b* and also on *n*, which however is not

a cleavage plane. The colour is white with a grey-blue shade; transparent or semi-transparent. Optically positive[1]); the acute bisectrix is parallel with the *a*-axis, the axial plane with *c* (001). Refraction indices for yellow light $\alpha = 1.6445$, $\beta = 1.6609$, $\gamma = 1.6878$. The axial angle, 2 V, is 77°.

When heated l. bursts into fragments and does not easily melt into a dark globule; it is not dissolved in acids. An analysis was undertaken by MAUZELIUS (in FLINK): SiO_2 56.94, TiO_2 13.20, ZrO_2 3.50, BaO 13.75, Na_2O 11.14, K_2O 0.56, H_2O 0.31 = 99.40. This corresponds with the formula $Ba\,Na_4\,(Ti_2O_2)\,(Si_2O_5)_5$. The mineral is not very closely related to other minerals.

L. is only recorded from a small area of the pegmatite-veins; the crystals are found in a microcrystalline mass of elpidite needles, in which large ægirine needles are found, besides smaller quantities of epididymite, albite, polylithionite etc. Since the first finding of this beautiful mineral no more material has been collected, any more than it has been found elsewhere in the world. The name which means a white wedge is formed in agreement with the two most characteristic properties of the mineral.

145. Sillimanite. $Al[AlSiO_5]$.

The Thule district.

Polaris Havn.

FIELDEN: Geol. Mag. New Ser. 2, 1895, p. 379.

Reported to have been found together with garnet and iolite (see those minerals).

The Holsteinsborg district.

Akugdleq (RAMBERG 1946). Constituent of a rock which besides s. consists of garnet and biotite. The s. is found as numerous prismatic crystals c. 10 mm long and 1 mm thick, apparently not bounded by crystal faces. The s. is white and translucent.

146. Dumortierite. $Al_4[Al_4BSi_3O_{19}OH]$.

The Thule district.

Port Foulke.

EMERSON: Amer. Geologist, 35, 1905, p. 94.

Described as fine blue prisms, which radiate from spinel crystals or lie scattered in the layer of mica between them. The strong pleochroism makes the determination quite indisputable.

---

[1]) FLINK calls the mineral optically negative in despite of the refractions quoted above which are determined by himself.

147. Diopside. $CaMg[Si_2O_6]$.

Diopside occurs in Greenland, in a great number of places, of which, however, here only a limited selection will be mentioned. As there are all possible stages of transition between d. and augite, it is not possible in all cases with certainty to distinguish them from each other. For the determination have been used refraction, fusibility and colour etc. The following crystal forms are used: *a* (100), *b* (010), *c* (001), *m* (110), *f* (310), *p* ($\bar{1}01$), *z* (021), *u* (111), *s* ($\bar{1}11$), *o* ($\bar{2}21$), *k* ($\bar{3}12$).

The Upernavik district.

Upernavik (Giesecke 17-7-1807, Rink). As to d. in parallel position with enstatite or hypersthene see these minerals. Rink has found diallage together with felspar; on the boundary towards the latter crystal faces *a m*, and *b* may be found; strong parting parallel with *a*. The colour dark-greyish green.

The Umanak district.

Sâtúnguit (Giesecke 10-6-1811). Found together with actinolite in granular limestone; d. partly consists of grains (malakonite), partly of small crystals (up to 1 cm) bounded by *a*, *b*, *m*, *f*, *c*, *u*, *p*, *s*, and *o*. Most of the faces of the prismal zone are shining, the remainder dull. The colour is light pale-green.

Storøen (Rink).

Rink: Ngr. p. 40.

Found as coccolite in granular aggregates or individual rounded grains in calcite.

Umanak (Rink). Crystallized together with small hypersthene crystals in fine-grained plagioclase; the specimen has been found as a boulder, but the label states that it originates from Anoritôq. The crystals are 2—3 mm in size; of faces only *a* and *b* are to be found. The colour brownish green.

Sarfarfik (Giesecke 1811). Small crystals (up to 1 cm) in dolomite; the only faces occurring are *a*, *b*, and *m*, very dull and decomposed. The colour greenish, most crystals more or less altered into talc.

The Jakobshavn district.

Jakobshavn district without definite locality (Rink). Crystallized in granular limestone together with actinolite, which has possibly been produced by alteration of the diopside. The size of the crystals up to 3 cm. Faces: *a*, *b*, *m*, strong parting parallel with *c*, fainter with *a*. The colour light-greyish green.

The Christianshaab district.

Claushavn (RINK). Crystallized (up to 2 cm) in grey, fine-grained dolomite together with scapolite and actinolite. The only faces (*a*, *b*, *m*) which can be determined with certainty are dull; parting parallel with *c*. The colour black-grey, under the microscope numerous black, branching bodies in a colourless substance are visible; angle of extinction about 37°.

Isua (GIESECKE 1-10-1807). Crystallized (2—20 mm) in cavities in a vein in mica schist. Form: *a*, *b*, *m*, *u*, *p*; parting very strong, parallel with *c*; less pronounced with *a*; the faces rather dull; the crystals nearly untransparent, of a dark greyish-green colour.

Nûk (RINK).

RINK: Ngr. p. 41.

Found in two different forms:

1. In dolomite, together with tremolite, in the shape of rather large individuals (up to 1 dm) without crystal form; the colour whitish grey, very strong parting parallel with (001). RINK has analyzed it and found MgO 7, CaO 25, Al_2O_3 7.3 and hardly any traces of FeO; this analysis does not agree with that of the diopside, but there are surely no other minerals with this composition in the existing specimens collected by RINK. Sometimes d. has been altered into an asbestoslike mineral (for details see talc).

2. Crystallized in quartz which has grown in the dolomite. Elongated prismatic; faces: *a*, *b*, and *c*; parting faint: *a* and *c*, the colour greyish green.

Orpigsôq (GIESECKE 1812). Large (up to 8 cm) crystals in granular limestone; faces: *a*, *b*, *c*, parting *c*, the colour greyish. D. for the greater part altered into tremolite.

Akugdlît (SYLOW 1883). Large individuals (up to 8 cm) which according to the label are found in gneiss. The colour dark-greenish; no parting faces. Is everywhere penetrated by actinolite in parallel position; the actinolite is found partly as larger and smaller aggregates, partly in the form of very small microscopical particles throughout the diopside. The colour in the case of both minerals is greenish black, and they are very close to the boundaries of augite and hornblende respectively.

The Egedesminde district.

Manîtsoq (GIESECKE 26-8-1812).

RINK: Ngr. p. 41.

SYLOW: M. o. G. 8, 1889, p. 28.

PJETURSSON: M. o. G. 14, 1898, p. 292.

Found in a vein in mica schist; according to GIESECKE the central

part of the vein consists of d. with scapolite and actinolite, and along the margin fine-grained limestone with tremolite. D. is partly found as large-grained aggregates and partly in regular crystals in cavities or grown into the limestone. It is nearly everywhere closely associated with actinolite, which frequently penetrates it in parallel position; often there are complete pseudomorphs. The smaller crystals are beautifully developed with shining faces: *a*, *b*, *m*, more rarely *f*; besides *u*, *p*, *z*, more

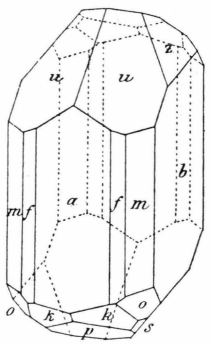


Fig. 56. Diopside. Manîtsoq.

rarely *s*, *o*, and *k* (fig. 56). The larger individuals have a very strong parting (*a*, *c*, often also *b*). The colour is most frequently faintly greenish grey.

Hareøen (ɔ: hare island). From of old there is a fragment of crystal, without indication of the name of the finder or the year in which it was found. The crystal is rather imperfectly developed; of faces *a*, *b*, and *m* occur, parting: *a* and to very small degree *c*. The colour is rather vividly green and in so far reminds somewhat of the Igíniarfik occurrence.

Akugdlît (Giesecke 17-8-1812, Sylow 1883). In most respects resembles the occurrence on Manîtsoq. According to Giesecke found in a crystalline schist-formation, partly as an independent layer with epidote and actinolite, partly in mica-schist or dolomite; on the specimens brought home the mineral is chiefly found together with actinolite and sometimes with apatite and anorthite. The crystal form is the same as that from Manîtsoq; most of it occurs in coarse-grained masses (sizes of individuals up to 2 dm). Parting (*c* and *a*) is unusually pronounced and regular, *b* less so.

Augpalârtoq (Giesecke 19-8-1810 and 13-8-1812). Is reported to occur together with tourmaline, epidote and garnet in mica schist, and also in layers together with pyrite.

Igíniarfik (Vibæk 1906). In a pegmatite consisting of oligoclase and quartz crystals of pyroxene and an amphibole are found, both with the same vividly emerald-green colour. The diopside is found as small crystals, generally a couple of millimetres in dimension; in most cases the only bounding faces found are those of the prismatic zone (*a*, *b*, *m*, and *f*); the terminal bounding is as a rule irregular or consists of a parting face. However, a single crystal rich in faces was found, which also in the prismatic zone had the faces (210) and (130), whereas the terminal bounding chiefly consisted of *p*, *e*, *u*, and *o*, besides several, quite small faces, which could not be determined with certainty.

Besides these crystals, there were also larger cleavage fragments (up to 4 by 3 by 1.5 cm), which showed very strong parting faces, of which those parallel with *c* have a strong pearly lustre and are produced by lamellæ at a fairly large distance from each other; whereas those which are parallel with *a* only have ordinary vitreous lustre, and seem to be due to closely packed, very thin lamellæ of amphibole, which mineral may also occur in larger areas embedded in a parallel position with the diopside. On (010) the angle of extinction is 35°—40° in the obtuse axial angle β; there is a strong pleochroism appearing in rather thick plates.

a and b pure green, c greenish yellow.

These colours are very nearly the same as in ægirine-augite, but the orientation mentioned above does not agree with this mineral. An analysis was undertaken by A. H. Nielsen in the "Øresunds Chemiske Fabriker": SiO_2 54.55, TiO_2 0, Fe_2O_3 0, FeO 1.63, Cr_2O_3 0.40, V_2O_3 0, MnO 0.05, MgO 17.61, CaO 25.25, F,O, H_2O 0 = 99.49. This mineral is thus a fairly pure diopside, and the strong colour and the pleochroism which is unusually pronounced for a diopside must presumably be due to the chromium contents.

Agto (Rink).

Rink: Ngr. p. 39.

Found together with garnet, oligoclase and quartz in layers of hornblende; strong parting (100); the colour impurely green.

Nagssugtôq (Pjetursson 1897). Coccolite in rounded grains in the dolomite; the colour impurely green.

The Holsteinsborg district.

Eqalugssuit (Fæster 1939). Fine-grained masses (sizes of grains mostly 1—2 mm) together with enstatite, also sometimes like very thin plates in the latter. The shape of the grains quite irregular. The colour emerald-green.

Arssalik (KORNERUP 1879). Coccolite as rounded, dark-green grains (1—3 mm) in lime-stone.

Súngoq (FÆSTER 1939). A coarse-grained mass (individuals about 1 cm in size) of d. with numerous graphite leaves, but without other minerals than a few calcite individuals. Towards cavities are sometimes found crystal faces *m*, *a*, *c*, sometimes *e*, but the faces are as a rule imperfectly developed. The mineral is colourless, clear and transparent.

Holsteinsborg. The coast, 3 km south-southwest of (KRARUP SCHMIDT 1871). Occurrence as that at Arssalik.

The Godthaab district.

Narssatsiaq (GIESECKE 10-8-1808). Found as a rounded mass (about 8 cm in diameter) enclosed in a hornblende rock. D. is large-grained (size of the individuals about 1 dm), rather pure of a greenish colour. Another specimen consists of larger individuals (up to 1 dm).

Narssaq (GIESECKE 13-9-1808). Indistinct crystals (1—10 mm) together with quartz, garnet, epidote and heulandite. Faces *a*, *b*, and *m*, parting *c*, colour dark-green.

East-Greenland.

Nûk (EBERLIN 1885). Small, rounded grains (1—2 mm) together with olivine in granular calcite; the colour blackish green.

Kap Adelaer (EBERLIN 1884). Small rounded grains (0.5—2 mm) together with garnet, calcite, epidote, quartz and heulandite. The colour dark-green.

148. Ægirine. $NaFe[Si_2O_6]$.

The Frederikshaab district.

Grönnedal (HOLST 1880).

TÖRNEBOHM: Geol. Fören. Förh. Stockholm, 6, 1883, p. 693.

CALLISEN: M. o. G. 131, No. 8, 1943.

Distributed as a constituent of rocks in the nepheline-syenite of this locality.

The Julianehaab district.

Nunarssuit (GIESECKE 1806). Crystals (up to 2 mm) on large arfvedsonite individuals. The form prismatic, *a*, *m*, and *s*. (description as in the case of the diopside); the faces rather curved and striated; the colour black, pleochroism as usual. Angle of extinction about 2°.

Nunarssuit, the immediate neighbourhood of (HOFF 1863), prismatic crystals penetrating quartz and microcline. The smaller ones are

black-green, fresh throughout with the faces *a*, *m* and sometimes *s*, well-developed and shining, the larger individuals (up to 4 cm) are light-greyish green with a strong parting in the direction of *a*; as a rule no distinct crystal form. Under the microscope æ. is always penetrated with a number of gritty impurities.

Qôrorssuaq (Giesecke 2-9-1806). Crystallized together with apatite crystals in fissures and cavities in nepheline-syenite. The open space is filled with calcite. The crystals 1—12 mm in size. The form (fig. 57) is flattened, which is unusual for ægirine. Combination: *a* (100), *b* (010), *c* (001), *m* (110), *p* ($\bar{1}01$), *s* ($\bar{1}11$), *o* ($\bar{2}21$). The relative sizes of the faces appear from the figure; the smaller faces are frequently lacking.

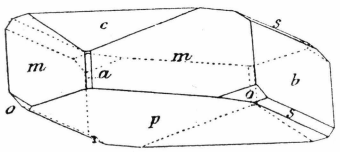


Fig. 57. Ægirine. Qôrorssuaq.

Most of the faces of the prism zone are well-developed and shining, the remainder always dull; *c* is recognizable from *p* by a great number of nearly microscopical irregularly shaped depressions. The colour is black, in a few spots, particularly on the prismatic faces, with a strong greenish tinge. The angle of extinction is about 3°.

From this locality Giesecke mentions crystallized hornblende in hexagonal prisms; as this mineral is not found in the collection brought home, it is possibly æ., which is meant.

Narssârssuk (Steenstrup 1888, Lützen's collection 1893, Flink 1897).

Flink: Geol. Fören. Förh. Stockholm 15, 1893, p. 207. — Zts. Kryst. 23, 1894, p. 176.

Ussing: M. o. G. 14, 1898, p. 176.

Flink: M. o. G. 24, 1901, p. 70.

Found in particularly large quantities, crystallized in pegmatite veins, and constituting the principal mass together with felspar. As æ. is more apt to resist decomposition than most other minerals, the crystals are found in large numbers lying loose in the gravel. The size is very varying; the largest crystals about 2 dm long and 8 cm thick.

The most usual combination is shown on fig. 58: *a* (100), *b* (010), *m* (110), *s* ($\bar{1}11$), *p* ($\bar{1}01$), *x* (461), and in rarer cases various other forms may be found. The faces of the prismatic zone are very shining, but strongly striated; the others are uneven and dull. From the above type there are only small deviations among the first formed crystals,

being the result of p by far predominating s, which may also entirely disappear. On the other hand the crystals of a later generation develop considerably greater differences, thus together with elpidite and leucosphenitеæ-crystals are found which, together with a, b, and m, are bounded by x (461) and possibly ($\bar{6}61$), form a very pointed pyramid (fig. 59), the top point of which is, however, always broken off. In other localities these faces are perfectly developed; other crystals are distinguished by the presence of (111) or, in rarer cases, also (001).

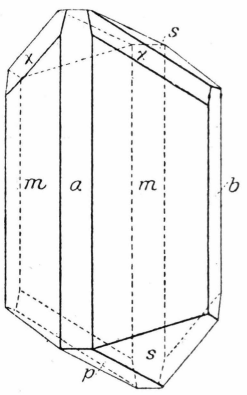


Fig. 58. Ægirine. Narssârssuk. (After Flink).

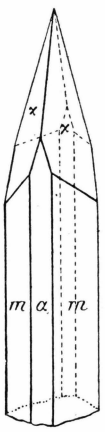


Fig. 59. Ægirine. Narssârssuk. (After Flink).

Sometimes twins occur according to the common law in augite with (100) as twin plane. These are surely always primary, but there also often occurs a secondary twin formation with (001) as twin plane, causing the formation of very perfect and reflecting parting faces.

An analysis of the æ. from Narssârssuk was performed in the laboratorium of Geological Survey in Sueden, by H. A. Nielsen with the following result: SiO_2 51.66, TiO_2 1.60, Al_2O_3 1.16, Fe_2O_3 29.23, FeO 1.61, MnO 0.72, MgO 0.25, CaO 1.30, Na_2O 11.93, K_2O 0.16, F 0.10, H_2O 0.26 = 99.98. This composition aggrees very well with that of other ægirines and with the theoretical formula $NaFe(SiO_3)_2$: SiO 52.0, Fe_2O_3 34.6, Na_2O 13.4 = 100.

The ægirine crystals from Narssârssuk are, to a larger extent than any of those from the other Greenland occurrences, covered with the brown substance called acmite, very distinct on faces a and b, which thus get a brown colour as distinguished from the green of the other faces. According to Ussing the difference between the brown and the green substances is chiefly due to the former containing less FeO and more Fe_2O_3 than the latter, whereas according to Flink it is cansed by part of the iron having vanished in the brown substance;

this alteration is connected with a decomposition of æ., which at last only consists of a loose aggregate of small yellowish crystals of a peculiar strongly birefringent ægirine-variety.

The region of Kangerdluarssuk (Giesecke 28-8-1806).

Allan: Thomson's Ann. Phil. 1, 1813, p. 99.

Kobell: Journ. prakt. Chemie 13, 1838, p. 3.

Rammelsberg: Pogg. Ann. 103, 1858, p. 273.

Kobell: Journ. prakt. Chemie, 91, 1864, p. 449.

Breithaupt: Berg.- u. hüttenm. Zeit. 1866, reprint, p. 50.

Doelter: Zts. Kryst. 4, 1880, p. 34.

Lorenzen: M. o. G. 2, 1881, p. 54. — Min. Soc. London, 5, 1882, p. 57.

Brøgger: Zts. Kryst., 16, 1890, p. 406.

Ussing: M. o. G. 14, 1898, p. 176.

Found in very great quantities as a main constituent of the nepheline-syenites and their pegmatite-veins. The succession varies greatly, the formation of the ægirine having commenced at the same time as the other constituents and continued until the congelation of the rock. The first formed grains have a crystal form, but as a rule only the prismatic zone (*m*, *a*, and *b*) is developed, and large beautiful crystals like those from the preceding locality are never found. Only small needle-shaped crystals have the face *s*. Twin lamellae with twin planes, *a* and *c* may occur.

As a rule æ. is completely black and not even translucent at the edges; only where it is found in thin needles it is vividly grass-green. In later alterations æ. frequently may have undergone a decoloration, which particular appears near the place where the crystals are broken; thus it has been altered into an acmite-like substance. Of interpositions there are generally only a quite negligible quantity in æ.

Acmite occurs in large quantities, produced by the alteration of arfvedsonite, sometimes also of eudialyte. The former generally consists of quite fine fibres parallel with the longitudinal direction of the arfvedsonite. Besides acmite, hæmatite or limonite may also occur. From partly altered arfvedsonite crystals it appears that the action begins in the outermost part or in irregular fissures.

Æ. has been made subject to a great number of analyses: by Kobell (1), Rammelsberg (2, specific gravity 3.589), Doelter (3). The analyses 1—3 are reported to be undertaken on arfvedsonite, whereas, as demonstrated by Lorenzen, arfvedsonite entirely or partly altered to æ. has in reality been used. Lorenzen (4, specific gravity 3.63). Rørdam (5—8 in Brøgger; all analyses have been undertaken on arfvedsonite altered into æ.; of 6—8 7—10 % dark mica, lepidomelan has been extracted before the analysis; in none of the analyses

the degree of oxidation of the iron has been determined). DETLEFSEN (9 in USSING; the analysis undertaken on arfvedsonite altered into æ., specific gravity 3.471).

	1	2	3	4	5	6	7	8	9
SiO_2 ...	49.27	51.22	52.22	49.04	48.73	52.12	49.90	49.50	44.19
Al_2O_3 ..	2.00	tr.	0.64	1.80	2.18	2.33	2.62	2.75	4.63
FeO_3 ..	14.58	23.75	28.15	29.54	37.32	32.33	32.99	32.86	34.67
FeO ...	23.00	7.80	5.35	4.82					1.16
MnO ..	0.62	1.12	0.54	tr.	—	—	0.05	0.06	0.45
CaO ...	1.50	2.08	2.19	2.70	—	—	—	—	2.35
MgO ...	0.42	0.90	1.45	tr.	0.58	0.62	0.57	0.60	0.18
Na_2O ..	8.00	10.58	10.11	13.31	10.24	10.95	12.88	13.01	11.61
K_2O ...	—	0.68	0.34	tr.	0.82	0.88	0.10	—	0.13
H_2O ...	—	0.16	—	—	0.72	0.77	1.07	1.53	0.30
Cl	0.24	—	—	—	—	—	—	—	—
	99.63	98.29	100.99	101.21	100.59	100.00	100.18	100.31	99.67

In connection with ægirine USSING also describes a green augite (ægirine—augite) occurring in several rocks of the area; there are possible stages of transition between the latter and the ægirine itself.

From the BERNBURG collections there are some very peculiar pseudomorphs after ægirine. As unaltered æ. is nowhere found together with the altered mineral, it is only possible to draw conclusions as to the origin of the pseudomorphs by means of their manner of occurrence and form. They are to be found as long, thin prisms, up to 8 cm long and 0.5 cm wide, placed in radiating groups; in the cross-sections of these a suggestion of the faces *a* and *m* of æ. are to be seen. The pseudomorphs are found in nearly pure granular albite of a rather loose consistency, and an unaltered æ. of the same size, form and manner of placing are found in the large individuals of microcline-microperthite from the pegmatite veins, and thus the original orthoclase may be imagined to have been altered to albite at the same time as the alteration process of the ægirine takes place. However, it is also possible to find fresh ægirine in the granular albite.

The pseudomorphs consist of quite loosely connected masses of the following constituents in fairly equal quantities.

1. Astrophyllite in small tabular crystals of up to 4 mm in length and 0.1 mm in width.

2. A mineral of a greyish colour and a consistency which is fine-grained even under the microscope, so that it is impossible to determine its optical constants.

3. Pseudomorphs of pyrolusite after enstatite; this latter mineral constitutes the central part of the crystals, whereas the outer parts are most frequently altered; the pseudomorphs therefore mostly

appear black with a metallic lustre. The faces may be well-developed, and in a few cases the faces of the pyroxene *a* and *m* with the characteristic cleavage angle of 87° may be proved directly by measuring. When treated with hydrochloric acid the pyrolusite disappears almost immediately, leaving a remainder consisting of an elongated, but otherwise irregularly shaped grain of pyroxene, which by its colourlessness, its parallel extinction and other properties may with certainty be proved to be an enstatite.

Qagssiarssuk (RINK). Found as a constituent of a syenite rock, containing large quantities of zircon crystals. Æ. is most frequently found in irregularly formed individuals; in a few cavities crystals (5—7 mm) are found; forms *a*, *m*, *b*, *p*. The faces most frequently well-developed, shining; the colour dark-green.

Igdlorliusalik (RINK). Numerous, elongated prismatic crystals found on radiating æ. The only faces occurring are *a* and *m*, all dull and greatly decomposed.

East-Greenland.

Kap Parry (NATHORST 1899).

NATHORST: Geol. Fören. Förh. 23, 1901, p. 301.

According to investigations undertaken by BÄCKSTRÖM found in an ægirine-quartz-syenite; like the quartz, æ. has no crystal form; the larger grains are grown together with arfvedsonite in parallel orientation.

149. Augite. $Ca_{6.5}Na_{0.5}\overset{II}{Fe}_7Mg_6(Al,\overset{III}{Fe},Ti)_2[Al_2Si_{14}O_{48}]$.

The Umanak district.

Qaersut.

PHALEN: Smithsonian Misc. Coll. 45, 1903, p. 195.

Here is a description of an olivine rock, probably the same as the one mentioned under qaersutite, which mineral is however not mentioned by PHALEN. Besides olivine the rock consists of augite, chlorite, felspar, biotite, magnetite, limonite, hematite and apatite. The augite is violet and is sometimes found in a characteristic poicilitic connection with the olivine. Analysis: SiO_2 49.49, Al_2O_3 5.45, Fe_2O_3 1.04, FeO 3.39, MgO 15.88, CaO 24.07, Na_2O 0.82, MnO 0.18 = 100.32. Specific gravity 2.890, or much less than is otherwise known in the pyroxenes.

The Godhavn district.

Uivfak.

NICOLAU: M. o. G. 24, 1901, p. 228.

Constituent of the iron-bearing basalt; is of a brownish colour, as a rule without crystal form, sometimes with *a* and *b*, very often

twins. The angle of extinction is 44°30′. Analysis: SiO_2 51.19, TiO_2 0.72, Al_2O_3 6.14, Mn_3O_4 0.53, Fe_2O_3 2.40, FeO 7.94, MgO 16.91, 14.56, Na_2O 0.72, K_2O 0.28 = 101.39.

The Frederikshaab district.

Tigssaluk (Holst 1880).

Törnebohm: Geol. Fören. Förh. Stockholm, 6, 1883, p. 702.

Found both in the ground-mass and as phenocrysts in olivine-proterobase. The colour is yellowish-brown to violet; there are rather good crystal faces with twin formation. The mineral is fresh, without enclosures.

150. Enstatite. $Mg_2Si_2O_6$.

The rhombic pyroxenes, enstatite, bronzite and hypersthene form a continuous series connected by all sorts of transitions, which can hardly with certainty be distinguished from each other without a chemical analysis. As is usually the case, the two former are classed together under the name of e., and the chief mark of distinction between e. and hypersthene has been that this mineral possesses the stronger refraction, the easier fusibility, the darker colour and the pleochroism which is generally very strong.

The Upernavik district.

Upernaviarssuk (Ryder 1887). A mixture of larger grains (up to 3 cm) and a more fine-grained ground-mass; the larger grains have a strong parting parallel with (010), accompanied by a strong pearly or metallic lustre and a brownish colour; otherwise the colour is dark-grey. The larger grains have a rather strong refraction and seems to be a bronzite, whereas the smaller ones are a less iron-bearing enstatite.

Qeqertaq (Ryder 1886). Irregularly shaped grains (up to about 1 cm) in actinolite; parting parallel with (010); colour light-brown.

Uigordlerssuaq (Giesecke 23-7-1807).

Kobell: Journ. prakt. Chemie, 36, 1845, p. 303.

Descloizeaux: Nouv. rech. sur les prop. optiques des cristaux, Paris, 1867, p. 45.

Occur as large crystal individuals (up to 1 dm) together with actinolite. The colour lighter or darker brown. Rather strong parting parallel with (010). Descloizeaux determined the optical axial angle ($2H_0$) at 114°15′. Analysis by Kobell: SiO_2 58.00, Al_2O_3 1.33, FeO 10.14, MgO 29.66, MnO 1.00 = 100.13. The mineral is thus a bronzite.

Upernavik (Giesecke 17-7-1807).

Rink: Ngr. p. 42.

The locality which undoubtedly contains very large quantities both

of enstatite and hypersthene is, according to Ussing, situated on the point of the small peninsula forming the northern boundary of the harbour. The mineral forms lenses in nearly vertical layers of gneiss, the largest of the lenses being 14 and 6 m in length and width respectively. The minerals are as a rule very impure and may contain diopside, felspar and other minerals; the former of these may be found in parallel intergrowth with the rhombic pyroxenes. GIESECKE and RINK call the minerals anthophyllite. RINK gives a more detailed description of them and says that the cleavage planes form the angle characteristic of hornblende, which must however, it seems, be due to a mistake. The analysis has been undertaken by RINK: SiO_2 56.73, MgO 28.05, FeO 16.11 = 100.89. It is thus certain that it is a hypersthene which has been analyzed. The colour of the enstatite shows various shades of brown, and there is no or only faint traces of pleochroism. The hypersthene is almost entirely black and even in thin splinters shows a strong pleochroism of the usual kind.

The Umanak district.

Itivdliarssuk (RINK).

RINK: Ngr. p. 42.

Found in granular form (individuals up to 1 cm in size) together with actinolite. The colour light-brown. The refraction points towards the mineral being bronzite.

Umanak (RINK).

RINK: Ngr. p. 40.

From a large block at the foot of the steep slopes there are some specimens of coarse-grained bronzite (individuals about 5 cm in size) with smaller quantities of biotite. Particularly strong parting parallel with (010), accompanied by metallic lustre. The colour light-brownish, but the material is very impure because of iron associations.

The Ritenbenk district.

Asuk (STEENSTRUP 1872).

STEENSTRUP: Vid. Medd. Nat. Foren. 1875, p. 296.

TÖRNEBOHM: Bihang Vet.-Akad. Handl. 5, 1875, No. 10, p. 18.

NICOLAU: M. o. G. 24, 1901, p. 237.

In an iron-bearing andesitic rock consisting of enstatite and labradorite small and sparse phenocrysts are found; they are of a dark-green mineral, which by STEENSTRUP was supposed to be olivine, but later on has proved to be enstatite. The birefringence is measured at 0.0097, which corresponds with what is usual in this mineral; the angle of cleavage is 88°42′. The crystals are developed, but the faces are indefinable. Pleochroism lacking.

The Egedesminde district.

Eqalugssuit (FÆSTER 1939). A peculiar rock, almost exclusively consisting of enstatite with the exception of a few quite small indefinable black grains. The enstatite consists of a ground-mass of a more porous consistency, in which a great number of crystals are found of all possible sizes, from microscopic thin needles to such as are about 8 cm long and 5 cm thick. The crystals are bounded by (100) and (001), no terminal faces. The ground-mass is white, the crystals light-grey. Both refraction and colour point towards the presence of enstatite, almost free from iron.

The Holsteinsborg district.

Eqalugssuit on the northern side of Isortoq (FÆSTER 1937). Granular mass, grains up to 2 cm in size, together with diopside and smaller quantities of biotite. The colour is brown; rather strong parting parallel with (010), in which direction also quite thin lamellae of the diopside may be found.

Sarfanguaq (SØREN HANSEN). Large crystals (up to 6 cm) embedded in an asbest-like anthophyllite, partly penetrated by this mineral and by muscovite. The only crystal face is (010) rather imperfectly developed, dull. The colour dark-brownish.

The Godthaab district.

Qarajap Ilua (STEENSTRUP 1888). Large crystal fragments of up to 1 dm in length, together with a small amount of phlogopite.

Qarajat (NYEBOE 1915). Fragments with phlogopite, greatly resembling the preceding occurrence.

Aunikasik at Qarajat (FÆSTER 1944). The combination of minerals in this occurrence has been described under olivine (p. 187). The enstatite occurs more particularly mixed with large quantities of olivine and also in many localities mixed with fibrous anthophyllite. The enstatite from the three occurrences is of the same kind, and it is also rather uncertain what their position is in relation to one another. The colour is brownish; it has a rather strong parting parallel with (010); if it is possible to find sufficiently thick, transparent faces, a pleochroism may be seen like that of hypersthene. The refraction rather points in the direction of a bronzite.

Fiskenæsset.

DESCLOIZEAUX: Manuel de Minéralogie, 1, p. 76.

USSING: Öfvers. Vet.-Akad. Handl. Stockholm, 1889, No. 1. — Zeits. f. Kryst. 15, 1889, p. 614.

LORENZEN: M. o. G. 7, 1893, p. 24.

Found in the sapphirine-bearing rock of type 2 (Ussing) which, in addition to the constituents already mentioned, contains spinel and a very small quantity of a light-brown mica. Sometimes the enstatite has a crystal form, sometimes it is irregular. Faces observed are (100) and (010). Terminal faces lacking. Parting parallel with the same faces. On cleavage fragments the prismatic angle has been measured at 88°12′; specific gravity 3.21 (Lorenzen) 3.205 (Ussing); pleochroism distinct, c. being light-brown, the other directions brownish-red. The axial angle Ussing determines at: $2H_a = 90°56'$ and $2H_0$ = about 119°; from these 2V is calculated = about 79° and $\beta = 1.65$; this value is greater than is otherwise known in enstatite, and by immersion I have determined it at about 1.56. Once lamellae of a monoclinic pyroxene are found embedded in the enstatite, sometimes also microscopical rutile needles.

Analysis undertaken by Lorenzen: SiO_2 55.04, Al_2O_3 3.35, Fe_2O_3 5.71, MgO 33.98, loss at ignition 1.78 = 99.86.

Descloizeaux calls the mineral amphibole, Lorenzen describes it as kupfferite, classing it with anthophyllite; Ussing has proved that it must be a bronzite.

The Julianehaab district.

Kangerdluarssuk. As to pseudomorphs of pyrolusite after enstatite occurring in pseudomorphs after ægirine see this mineral (p. 274).

East-Greenland.

Paornakajît in Sermilik (Bay 1896, Rüttel 1902, Einar Mikkelsen 1946).

Bay: M. o. G. 19, 1896, p. 176.

From pictures taken by Mikkelsen, it is seen that the occurrence consists of a vertical vein in the sea cliffs with a thickness of about 12 meters. Rüttel has collected samples partly of very considerable size and consisting of bronzite, asbestus-like anthophyllite and mica (biotite or phlogopite). The bronzite occurs in the form of large (up to 1 dm) irregular individuals, which in numerous places are penetrated by asbestus-fibres, most frequently orientated parallel with the *c*-axis of the bronzite, and with mica-shells which are always placed parallel with the face of the bronzite (010). Freely developed crystal faces are rarely found. (010), (100) and (110) are rather dull and uneven. The colour impurely brownish.

Kong Oscars Havn (Nordenskjöld 1883).

Törnebohm: Geol. Fören. Förh. Stockholm, 8, 1886, p. 441.

Found sparsely in dark-grey bronzite diabase.

151. Hypersthene. $(Mg,Fe)_2[Si_2O_6]$.

The Upernavik district.

Upernavik. As to hypersthene from this locality see what has been said under enstatite.

The Umanak district.

Umanak (RINK).

RINK: Ngr. p. 42.

Here a number of different forms have been found, chiefly as boulders; thus for instance a peridotitic mass (by RINK termed a quartz-mass) with irregular grains of h. which RINK terms anthophyllite, but which is a rhombic pyroxene. RINK reports that it yielded an analysis in complete agreement with the mineral from Upernavik (see above p. 277), and it is thus to be presumed that we also here have a hypersthene but close to the enstatite in all its properties.

Another boulder contains h. in a fine-grained mass of actinolite together with mica and other minerals. The two predominant minerals penetrate each other with a parallel orientation in the manner of graphic granite. The pleochroism distinct.

A third boulder which is labelled Anoritoq consists of a fine-grained mixture of h. with diopside and plagioclase, the two former being formed first and therefore having a fairly crystal shape. The crystals of h. are small (about 1 mm) and are found in extremely great quantities; they are bounded by (100), (010) and (110). The pleochroism strong.

The Holsteinsborg district.

Kællingehætten (ɔ: old womans hood) (FÆSTER) Found at the foot of K. together with ilmenite at the boundary of a pegmatite mass with antiperthitic felspar; in this also larger grains of h. (up to 2 cm in length) are found. It is almost rust-coloured, with a strong pleochroism.

The Godthaab district.

"Fiskenæsset district" without any definite locality (RINK). Rather large individuals (up to 5 cm) in granular actinolite, which also may occur as a regular intergrowth in h. The colour brown. The pleochroism strong.

The Julianehaab district.

Igaliko.

DESCLOIZEAUX: Nouv. rech. sur les prop. opt. des cristaux, Paris, 1867, p. 65.

Here mention is made of a greenish-grey h. with an optical axial angle $2\,H = 74°57^1/_2'$ and with a faint metallic lustre on the most pronounced cleavage plane; it is reported to be found in a hyperite.

Friedrichsthal (Nordenskjöld 1883).

Törnebohm: Geol. Fören. Förh. Stockholm, 8, 1886, p. 439.

Found in a gabbro, which further consists of plagioclase, diallage and mica.

East-Greenland.

Karra Akungnait, southern (Eberlin 1884).

Crystallized in a fine-grained rock, the ground-mass of which consists of plagioclase and a light-green pyroxene; in this mass large hornblende crystals are segregated, together with biotite and hypersthene. The latter generally occurs as fairly well-developed crystals (about 1 cm); however, the faces are frequently broken by intergrowth of the other minerals growing into them. The form is short-prismatic, bounded by (100), (010), (110) and (212). The faces are as a rule uneven and dull, the colour impure in all brownish-grey shades; the pleochroism very strong.

Kong Oscars Havn (Nordenskjöld 1883).

Törnebohm: Geol. Fören. Förh., Stockholm, 8, 1886, p. 440.

Found as a constituent in a fine-grained pyroxene-gneiss.

Birds Bay on Clavering Ø (Chr. Poulsen 1929). From the Archean rock at the eastern quartz vein some specimens of a pegmatitic mass are at hand; they chiefly consist of h. mixed with hornblende, labradorite and various other minerals; the individuals may be several cm in diameter, but always contain large quantities of the other minerals enclosed in them. The colour brown to black, with a rather strong metallic lustre; the pleochroism is faint, and the mineral is possibly on the transition stage to bronzite.

152. Cummingtonite. $(Mg,Fe)_{14}(OH)_4Si_{16}O_{44}$.

The Julianehaab district.

Qeqertarssursuaq, one of the Kitsigsut Islands (1870).

Janowsky: Ber. d. D. Chem. Gesell. Berlin 1873, p. 1230.

Vrba: Sitzb. d. k. Akad. der Wiss. Wien, 69, 1874, p. 12.

Found in coarse-grained nepheline-syenite together with felspar, nepheline and eudialyte in the shape of columnar individuals; the colour is black, and only the thinnest edges are translucent with a greenish colour. The cleavage angle is 123°57′. Easily fusible to a black magnetic globule. Analysis undertaken by Janowsky: SiO_2 44.24, FeO 29.46, Fe_2O_3 4.27, Al $_2O_3$ 1.80, MnO 2.21, CaO 8.84, MgO 3.11, K_2O 1.31, Na_2O 0.83, P_2O_5 2.33, H_2O 1.35 = 99.75. This composition does not agree with any known mineral. From hornblende, which the mineral in question resembles most nearly in properties, it differs by the small

contents of Al_2O_3 and CaO. Perhaps it may be a c., which is unusually rich in CaO and FeO.

Greenland without definite locality.

Descloizeaux: Nouvelles recherches etc. 1867, p. 115.

Here mention is made of a Greenland mineral called amphibole-anthophyllite. It is of a foliated-radiating consistency; the colour is yellowish-grey, the cleavage angle about 125°. The mineral fuses with difficulty. The specific gravity 3.45, the angle of extinction 16—17°, $2H_0$ with red light $119^1/_2°$. Analysis undertaken by Lechartier: SiO_2 55.82, MgO 20.61, CaO 1.14, FeO + MnO 20.22, Al_2O_3 0.47, loss 2.10 = 100.36. In most respects the mineral agrees so completely with c. that it must undoubtedly be classed with it.

153. Iron Richterite. $(Na_1K)_{2-3}Ca_{2-3}\overset{II}{Fe}_{1-2}Mg_{10}[(O_1OH)_4(\overset{III}{Al_1Fe})_{0-1}Si_{15-16}O_{44}]$.

The Umanak district.

Store Qarajaq Isbræ.

Belowsky: Zts. d. geol. Gesell. 57, 1905, p. 33.

Sjögren: Geol. Fören. Förh., Stockholm, 13, 1891, p. 604.

Hamberg: ibid. p. 801.

Sjögren: ibid. 14, 1891, p. 263.

Belowsky describes a rock from the right bank of the glacier, which consists of orthoclase, oligoclase-albite and a blue fibrous mineral, greatly resembling crocidolite, though distinguished from it for instance by having a positive, lengthwise sign. The arrangement of the fibres is parallel or radiating; when the light falls upon them, they are light-bluish, whereas in transmitted light they are yellowish-green with pleochroism from bluish-green to impure yellowish-green. Refraction about 1.63. The obliquity of the extinction is 16—19°, the birefringence is medium-sized. The mineral in all respects agrees well with one from Långban described by Sjögren and first called astochite, which name was later on by Hamberg corrected to richterite, as the difference between the two minerals was very small; at a still later period the name was once more changed by Sjögren to soda richterite. There is no doubt that the Greenland mineral in question, because of its typical properties, must belong together with richterite. The chemical composition can hardly be said to be accurately determined; in an analysis undertaken by Belowsky the composition is determined by detracting a total of about 76 % felspar from the analysis of the rock, the remaining 24 % being regarded as richterite. As distinguished from the Långban mineral no manganese was found, but great quantities of iron, for which reason the above-mentioned name has been proposed.

154. Tremolite. $Ca_4Mg_{4-10}Fe_{0-6}[(OH)_4Si_{16}O_{44}]$

The two minerals, tremolite and actinolite, are interconnected with all possible stages of transitions, and so they can naturally not always be distinguished from each other without analysis. In the following they are determined, partly by the colour (white-grey in t., green in a.) partly by the refraction; when immersed in acetylene-tetrabromine (n = 1.637) γ in tremoline is nearly always smaller than the refraction index of the liquid, whereas in actinolite it is about the same, or greater. T. has not been found in South-Greenland.

The Umanak district.

Marmorilik (Noe-Nygaard 1939). In the marble there are here and there lumps of this mineral in the form of groups of columnar aggregates, up to 8 cm in length, the individual columns being about 1 mm thick. The colour is as a rule pure white.

Uvkusigssat (Giesecke 3-5-1811).

Rink: Ngr. p. 41.

Giesecke mentions amiant and asbestus; the samples at hand are, however, of a rather coarsely fibrous consistency. Rink's material consists of crystals (2—4 cm in length) in dolomite, together with mica, pyrite, quartz and diopside. The crystals are either isolated or arranged in radiating groups; they are bounded by (110) and (010). The colour greyish.

Sarfarfik (Rink).

Rink: Ngr. p. 41.

Occurs like the preceding.

The Godhavn district.

Godhavn (J. N. Nygaard 1909). In the lake near the Arctic Station a sample of dolomite was found, with a great number of tremolite crystals enclosed in it; the length up to 2—3 cm, the width about 5 mm; when the dolomite is dissolved, crystals are attained with the faces (110), (100) and (010) the two latter narrower; no terminal faces. The colour dark-grey or nearly black, which is due to numerous black particles enclosed in a clear ground-mass.

The Jakobshavn district.

Jakobshavn (Pfaff 1874). Crystallized in grey dolomite; the crystals elongated up to 4 cm long, very irregular and dissolved into thinner hypoparallel elements. The colour grey.

The Christianshaab district.

Nûk (Rink).

Rink: Ngr. p. 41.

Found in light-grey dolomite together with diopside, talc, graphite, mica and quartz, in the shape of irregular radiating masses; a few indivi-

duals attain a length of 1 dm. The colour is light, greyish; frequently a distinct parting parallel with (100).

Kangersuneq, northern side of — (Sylow 1883).

Sylow: M. o. G. 8, 1889, p. 27.

The here mentioned tremolite in pegmatite has proved to be anthophyllite.

Orpigsoq (Giesecke 4-9-1811). Radiating masses in granular limestone together with diopside and to a certain extent as pseudomorphs after the latter; the colour greyish.

The Egedesminde district.

Egedesminde (Giesecke 5-10-1807). Crystallized (2—3 cm) in dolomite together with muscovite; (110) is very pronounced and also (100). The colour greyish.

Manîtsoq (Giesecke 26-8-1812).

Rink: Ngr. p. 41.

Rammelsberg: Pogg. Ann. 103, 1858, p. 295.

Sylow: M. o. G. 8, 1889, p. 28.

Pjetursson: M. o. G. 14, 1898, p. 292.

Undoubtedly the most considerable occurrence of t. in Greenland. According to Giesecke it is found in dolomite, lying on both sides of a layer of salite with scapolite and actinolite, and on the outside again bounding on mica-schists. The appearance of the tremolite is very different; sometimes it occurs in regular crystals, bounded by (110), most frequently however in radiating and fibrous masses, the single individuals of which may have a length of up to 15 cm. Frequently it branches radially, often in star-shaped groups; it may also be quite asbestus-like with fibres which are easily torn apart, but are quite brittle. The colour greyish or whitish, sometimes with a faintly greenish tinge. Specific gravity, according to Rammelsberg, 3.004. Analyses of the greenish-white, fibrous t. has been undertaken by Rammelsberg:

SiO_2	54.71	56.60
CaO	15.06	15.58
MgO	23.92	24.74
FeO	2.41	2.48
Loss at ign...	3.33	—
	99.43	99.40

Akugdlît (Giesecke 17-8-1812).

Occurs in granular limestone together with mica, fine-grained blue apatite and sometimes scapolite and diopside; the latter minerals, however, seem to border on lime and to some extent to belong to the actino-

lite-bearing layers. According to GIESECKE there are in all three different layers of granular limestone with tremolite. The appearance of the mineral is rather like that from Manîtsoq.

Qeqertarssuaq at Nivâq Fjord (KOCH 1908). Regularly fibrous mass almost without other minerals. The fibres rather closely connected and also rather coarse and brittle. The colour greenish-grey.

155. Actinolite. (The composition nearly as that of tremolite, but with *Na* or *Al*).

A. is rather widely distributed as rock-forming mineral, and so only part of the more striking or characteristic occurrences will be mentioned in the following. The distinction from tremolite has been dealt with under this mineral; from hornblende a. is more particularly distinguished by the form, the colour and the fusibility, but more than anything else perhaps by the refraction; as a general rule it may be said that when γ in the mineral is greater than the refraction of c. 1.658, it will be hornblende and else actinolite.

The Upernavik district.

Uigordlerssuaq (GIESECKE 23-7-1807). Found as a granular aggregate on a larger enstatite crystal. The colour vividly green.

Upernavik.

RINK: Ngr. p. 42.

The a. or smaragdite, which is recorded to be found on the islands round Upernavik together with anthophyllite, is presumably diopside, here accompanying hypersthene.

The Umanak district.

Umiamâko (PETER DAVIDSEN 1947). Here are collected samples of an actinolite in the form of a rather coarse asbestus; the substance is mostly coherent and the fibres are difficultly separated from each other. The colour is greenish-grey.

Ubekendt Eiland (MØLDRUP 1888). Found in the form of asbestus, which in some cases is rather hard and difficult to divide, in others very finely fibrous and soft; it seems to be the Greenland asbestus most fit for use, as rather long and pliant fibres can be obtained. The labels record "Ubekendt Eiland Distrikt", which might point towards the specimens having been received from the inhabitants and so possibly originating from a neighbouring locality.

Uvkusigssat (GIESECKE 3-5-1811). Found partly as a constituent of mica-schist, partly in the form of very coarsely fibrous aggregates of a greyish-green colour. GIESECKE also mentions amiant from that locality, and it is possible that the above-mentioned asbestus may originate from there.

Satúnguit (GIESECKE 10-6-1811). Found as a coarse and irregular radiating aggregate of a dark-green colour, and as single crystals in granular diopside, partly projecting into calcite. Form (100) and (110) with a distinct parting parallel with (001). The colour dark greyish-green.

Itivdliarssuk (RINK).

RINK: Ngr. p. 42.

Found in a granular mass, mixed with bronzite; the colour light-green.

Akugdlît (GIESECKE 25-4-1811). Dark-green crystals (2—3 cm long) in a coarse, asbestus-like, light-green mass. The only face on the crystals (110).

The Christianshaab district.

Claushavn (RINK). Crystallized in dark-grey, fine-grained dolomite together with diopside and scapolite. The crystals small (2—3 cm long), regularly developed with shining faces. Only form: (110). Dark-grey, semitransparent.

Isua (GIESECKE 1-10-1807). Occurs in dolomite, partly as pseudomorphs after diopside, and partly as irregularly shaped, prismatic crystals or radiating masses. The colour grey or greyish-white.

Nûk (RINK).

RINK: Ngr. p. 41.

Found together with quartz and diopside, in all probability exclusively produced by an alteration of this mineral; the colour greenish.

Akugdlît (SYLOW 1883). As to occurrence etc. see diopside (p. 267). The actinolite bounds on hornblende; γ is just 1.658. The mineral rather heavily fusible. No visible pleochroism.

The Egedesminde district.

Isuamiut (GIESECKE 28-8-1812). Forms radiating aggregates in garnet-bearing mica-schist, with the individuals arranged in sheaf-like masses and beautifully curved. The greenish-black colour rather suggests hornblende; refraction and fusibility point, like the mineral from the preceding occurrence, towards something between a. and hornblende. The pleochroism the common one for hornblende.

Manîtsoq (GIESECKE 26-8-1812).

RINK: Ngr. p. 41.

Found together with diopside, partly in kidney-shaped masses, partly as entire layers; according to GIESECKE a single layer of this kind is found, being on both sides surrounded by lime-stone with tre-

molite. The actinolite occurs as irregular masses together with diopside and sometimes with titanite, oligoclase and quartz; it frequently forms pseudomorphs after diopside. Crystals may either be found projecting freely or grown into calcite; form (100) and (110), the former as a rule the prevailing one; the faces frequently well-developed. The colour greyish-green.

Akugdlît (GIESECKE 17-8-1812). According to GIESECKE found in layers interchanging with enstatite and epidote. On the samples brought home no epidote is found, but besides diopside layers consisting of scapolite and apatite occur. Crystal form etc. as in the preceding locality.

The Holsteinsborg district.

Kangerdluarssuk (NYEBOE 1915). Coarse radiating aggregate of a dark greyish-green colour together with biotite. Pleochroism rather marked.

The Godthaab district.

Naujanguit (GIESECKE 1808). Found in mica and talc-schist, partly as thicker individuals, darker green and rather transparent, partly with all stages of transition to light greyish-green asbestus. Also crystals of the former kind may be found imbedded in the asbestus.

Narssatsiaq (GIESECKE 8-8-1808). Found in a coarse-grained form, together with hornblende and biotite; also in granular aggregate together with anthophyllite and finally as scattered crystals in talc, form (110) and (010) with well-developed, shining faces. The colour lighter or darker green.

Amitsuarssuk (PINGEL). Crystallized in a fine-grained talc with small mica-leaves; the crystals frequently curved and branching, bounded by (110), (100) and (010). The faces very well-developed and shining, the colour green.

Mannik on the southern side of the mouth of Amitsuarssuk (FÆSTER 1937). The occurrence possibly identical with the preceding one, but this occurrence of a. is surely the most conspicuous in Greenland. The crystals may attain a length of 15 cm with a thickness of about 1 mm and are found in radiating groups, or as scattered, nearly parallel crystals in light-brown or greenish talc. Faces essentially (110); besides (100) and (010). The colour greyish-green. Pleochroism hardly visible.

Qarajat (GIESECKE 13-9-1808). Found in talc together with asbestus-like anthophyllite. The actinolite is found partly as a radiating aggregate of a strong green colour, partly as a coarse asbestus of a greenish-white colour. Sometimes crystals are found projecting into the

asbestus; no other faces than (110). Originating from the same locality a sample collected in 1876 by the physician SØRENSEN and consisting of a very fine-grained a. together with dolomite and tourmaline; in both of these minerals there are numerous actinolite crystals (about 1 mm); the form short-prismatic with (100), (010), (110) and (011). The faces rather curved and dull, the colour yellowish-green.

"Fiskenæsset District", without specified locality (RINK). Rather large individuals (up to about 5 cm) mixed with hypersthene, most frequently in orientated intergrowth. The colour dark-greenish.

The Frederikshaab district.

Kingigtoq (GIESECKE 10-6-1809). Found as an irregular aggregate, coarsely asbestus-like, sometimes passing into the parallel-fibrous. Besides a single specimen is found, completely resembling those from Amitsuarssuk and Mannik, which were mentioned above; it is, however, hardly probable that GIESECKE has mistaken the one locality for the other.

East Greenland.

Kap Adelaer (EBERLIN 1884). In a pegmatitic mass, chiefly consisting of microcline, a number of small irregular crystals of a. are found together with titanite. The colour impure, greenish.

(Nephrite).

This mineral is first mentioned from Greenland by SCHUMACHER (Versuch eines Verzeichnisses der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 22); however, the description does not seem to agree with n., especially not the specific gravity, 2.764, which is far too small. Furthermore GIESECKE on several occasions mentions the mineral, as for instance from Qaqarssuit in the Christianshaab district (1-10-1807) where it is reported to form veins in mica-schist together with jade, which name is used both for n. and jadeite, and from Ujaragssuaq in the Godthaab district (5-8-1808), where a stone resembling "Beilstein" (another name for n.) is mentioned; it is of a "dunkellauchgrün" colour and occurs in considerable quantities. However, these determinations cannot be regarded as certain, and thus it has not as yet been proved that this rare and valuable mineral occurs in Greenland.

156. Riebeckite. $(Na,K)_{4-6}Ca_{0-1}Mg_{0-2}\overset{II}{Fe}_{3-8}\overset{III}{Fe}_{0-6}[(O,OH)_4Al_{0-1}Si_{10-16}O_{44}]$.

The Julianehaab district.

Narssârssuk (STEENSTRUP 1888).
USSING: M. o. G. 14, 1898, p. 205.
FLINK: M. o. G. 24, 1901, p. 80.
GORDON: Proc. Akad. Nat. Sci. Phil. 79, 1927, p. 202.

Found though not in particularly large quantities, together with several other of the minerals characteristic of the occurrence, chiefly with the two most important of the minerals, felspar and ægirine. The crystals are rather small, about 1 cm in length and width, and they are, as far as is known, always closely connected with ægirine, either as thin fibres within the latter, or as projections on the sides of larger crystals, or forming a complete cover round a kernel. The two minerals have most frequently a parallel orientation.

The crystals have been investigated by FLINK and are bounded by (110) which is by far the prevailing face, and (100) and (101). The latter form is particularly interesting, being as a rule greatly curved, though in a few smaller crystals it may be plane and accurately determinable. According to USSING the pleochroism is a very deep indigo-blue; b dark greyish-blue, c light yellowish-green, whereas FLINK has a and b bluish-black, c greyish-brown with a greenish tinge. While these two schemes agree fairly well with each other and also with what is otherwise recorded of the mineral, GORDON gives a more differing scheme: X greyish-blue, Y yellow, Z dark-grey.

FLINK calls the mineral "arfvedsonite, type II (riebeckite)?"; but there is hardly any doubt that it agrees in all respects with a typical r.

An alteration from r. to crocidolite has been described and figured by USSING. At one end of the sample the r. is compact, at the other end it looks as if it were dissolved and altered, and the circumstance that the fragments of r., when farther removed from the large individual, are made to occupy quite irregular positions, points towards an alteration really having taken place in the direction indicated.

From N. a number of samples have been sent in, very porous and consisting of a skeleton of r., arfvedsonite, barkevikite or ægirine in one combined individual, whereas the meshes are entirely or in part filled with mica, calcite or other minerals. It is here presumably a question of rather intricate alteration processes of a mineral, which was perhaps originally either r. or arfvedsonite.

The region of Kangerdluarssuk (STEENSTRUP 1888).

USSING: M. o. G. 14, 1898, p. 212.

According to USSING the mineral found here is not a typical r. but something between r. and arfvedsonite. It is grown together with a yellowish-brown hornblende in a parallel position, mostly at the extreme boundary plans of its individuals, but also as strings and spots in the interior, and it has probably been produced by an alteration of the hornblende. The absorption colours agree quite with those of r., the obliquity of extinction is a little larger, 7—10, more rarely as much as 30°.

As to the possible occurrence of r. in arfvedsonite granite, see what is said under this mineral.

157. Arfvedsonite. $Na_5Ca(\overset{II}{Fe},Mg,Ti)_7\overset{II}{Fe}_3[(OH)_4(Al,\overset{III}{Fe}),Si_{15}O_{44}]$.

The Julianehaab district.

Inatsiaq (Rink). Found in a coarse-grained granite (pegmatite?) together with microcline, quartz, allanite and small zircon-crystals; together with a. is also found a brown hornblende (barkevikite?), and both of these minerals are grown into each other in a parallel position. Colour and pleochroism as usual.

Nunarssuit (Giesecke 7-7-1806).

Laube: Ber. d. k. k. Akad. d. Wiss. Wien. 68, 1873, p. 98.

A specimen sent in by the Rev. Vibæk in 1907 determines the finding place as a locality called Taserssuaq, close to the dwelling place. A. is found in granite-pegmatite together with microcline, quartz and smaller quantities of ægirine and fluorite. The individuals up to 10 cm in size; sometimes several individuals are enclosed in one felspar individual, while conversely one individual of a. may enclose quartz and felspar. Of crystal faces (110) and (010) are to be found. The mineral is distinguished by its numerous parting faces, parallel with (100) and (001); both may be developed in a very different degree and sometimes become entirely shining and reflecting.

Narssârssuk (Lytzen's collection 1893).

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 207.

Flink: M. o. G. 24, 1901, p. 77.

Gordon: Proc. Acad. Nat. Sci. Phil. 79, 1927, p. 193.

Found in comparatively small quantities in the pegmatite veins, frequently together with needle-shaped ægirine crystals, both of a later origin than the principal mass of the pegmatite; they are also frequently found on felspar crystals. The crystals are generally 1—2 mm in size, but may become as large as 1—2 cm; they are most frequently short-prismatic, the small ones have sometimes particularly well-developed faces, the most important forms being *b* (010), *m* (110), *l* (130), *p* (101), *r* (011), *z* (121) (fig. 60). Faces (110) and (010) are most frequently equally developed, so that the cross-section of the crystal is hexagonal, sometimes (010) prevails, and (130) is small and often entirely lacking like (100), which is also sometimes to be found. The terminal faces are generally not so beautifully developed as those of the prismatic zone. A single twin-crystal has been found.

Since Flink's description a large quantity of material has been sent in, collected by Greenlanders, among others samples weighing up

to 0.5 kg; they are characteristic in that no traces of other minera's are to be found in connection with them. Like fragments collected by GORDON in 1923 they show the properties of the mineral particularly nice; the colour is purely black and the cleavage planes extremely shining and reflecting. FLINK records the specific gravity at 3.021, which is surely wrong; GORDON records it at 3.460. In contradistinction to earlier authors, GORDON is of the opinion that a. is normal-symmetric; the obliquity of distinction is by BRØGGER determined at 14°, by FLINK and GORDON at about 10°.

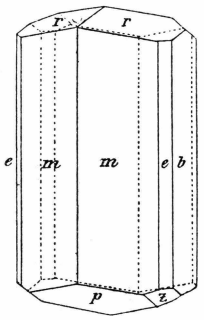


Fig. 60. Arfvedsonite. Narssârssuk. (After FLINK).

To this it must be observed that it is the optical conditions which are particularly difficult, not to say impossible, to determine with certainty. This is partly due to the fact of the mineral being so little translucent, in connection with the faint birefringence, which causes the figures seen in a convergent light to be very obscure. Add to this that the optical conditions of a. are in several respects quite abnormal; in sections after (010) for instance, no complete extinction is found, but a series of colours which, however, cannot be regarded as a dispersion in the usual sense of the word, as a complete extinction does not take place in unicoloured light. Further, the colours seen by the application of a gypsum differ entirely from what is otherwise known. As to the position of the optical axial plane, it seems in some sections to coincide with the plan of symmetry in others to be normally on it.

The region of Kangerdluarssuk (GIESECKE 28-6-1806).

ALLAN: Thomson's Ann. Phil. 1, 1813, p. 99.
BROOKE: ibid. 5, 1823, p. 381.
ARFVEDSON: Berz. Jahresbericht, 4, 1825, p. 149.
THOMSON: Ann. of New-York, 1828, p. 9, Ann. des mines. 3, Ser. 1, 1832, p. 192.
FORCHHAMMER: Oversigt Vid. Selsk. Forh. 1835—36, p. 24.
KOBELL: Journ. f. prakt. Chemie, 13, 1838, p. 3.
RAMMELSBERG: Pogg. Ann. 103, 1858, p. 273.
KOBELL: Journ. f. prakt. Chemie, 91, 1864, p. 449.
BREITHAUPT: Berg- u. hüttenm. Zeits. 1866, reprint, p. 50.

Doelter: Zts. f. Kryst. 4, 1880, p. 34.
Lorenzen: M. o. G. 2, 1881, p. 54, Min. Soc. London, 5, 1882, p. 57.
Berwerth: Sitzungsber. d. k. k. Akad. d. Wiss. Wien, 85, 1882, p. 168.
Brøgger: Zts. f. Kryst. 16, 1890, p. 398.
Rosenbusch: Mikr. Physiographie, 1, 1892, p. 564.
Ussing: M. o. G. 14, 1898, p. 176.
Gordon: Proc. Akad. Nat. Sci. Phil. 79, 1927, p. 196.

A. is found in very great quantities in the nepheline-syenites of this area and also in the pegmatite-veins; here it may occur in very large individuals up to half a metre in diameter, particularly in the occurrence of Nunarssuatsiaq. A. has begun to crystallize at an early stage, most frequently, however, it is one of the youngest constituents.

Crystals have been found in rather considerable quantities in the granular albite, which accompanies the pegmatite veins; most of them are rather perfectly developed, elongated with a length of about 3—4 cm. Lorenzen describes crystals from the pegmatite, 20 by 8 cm in dimension, but they are very incomplete.

A special investigation of the crystals has been undertaken by Brøgger; most of them are hexagonal in cross-section, with an equal development of (110) and (010); (310) has not been found. The terminal faces are chiefly the same, which are found on the crystals from Narssârssuk; however, (101) and (211) may sometimes prevail, and also small faces of a form (031) may be found. Twins are rather common; of terminal faces they most frequently only have *z* (121) without a re-entrant angle.

The colour of most crystals is black, but becomes grey when decomposed. The faces of the prismatic zone may be shining; otherwise the faces are dull, but beautifully plane, and striation never occurs. The cleavage planes in the larger individuals may sometimes be purely black and shining, but most frequently they are very uneven and of a more or less bluish or greyish colour, which may be due to an incipient decomposition, though mostly an intermixture of rather large quantities of foreign minerals, more particularly ægirine, which are parallel in orientation with a. Upon the whole the mineral in appearance greatly differs from the particularly pure mineral mentioned from the preceding locality.

An only specimen present in the Mineralogical Museum of Copenhagen has a very strong parting parallel with (001), by which means faces are produced which sometimes may be very perfectly reflecting.

The specific gravity is in most cases between 3.440 and 3.447; on a single occasion Gordon has 3.410. The obliquity of extinction is differently recorded, from 10 to 14°. The refraction β is indicated at values very close to 1.70, and the birefringence at 0.005. The pleochroism

is somewhat varying, and as usual it is rather difficult to describe the colours accurately. For the greater part of the Greenland arfvedsonite Ussing records: a very deep greenish-blue, b lavender-blue, c pale greenish-yellow, whereas Gordon records deep bluish-green for X, brownish-yellow for Y, bluish grey or green-blue grey for Z. For *a* in the arfvedsonite granites Ussing records colours, which approach those of riebeckite, and it would perhaps be most probable to class it with this mineral; Ussing considers this possibility, but calls the mineral a. chiefly on account of the obliquity of the extinction, which is something between those of the two minerals but nearest a. As mentioned above, it is very difficult to determine this angle with certainty, all the more when orientated sections are lacking, and it seems to rather an essential point that the riebeckite apparently mostly occurs in granitic rocks.

A. very often contains enclosures of the other minerals in the nepheline-syenites, frequently entering into a parallel intergrowth with ægirine. The arfvedsonite has often undergone an alteration, thus obtaining a greyish-brown colour and streak; there can hardly be any question of an actual decomposition, as the hardness seems to have increased, while the specific gravity is greater, viz. 3.600—3.611.

The analyses of the a. from Narssârssuk and Kangerdluarssuk have, for the sake of comparison, been placed together in the table below. The mineral from N. was analyzed by Washington (in Gordon, 1) and A. H. Nielsen (2), that from K. was analyzed by Forchhammer (3), Lorenzen (4), Berwerth (5), Shannon (in Gordon, 6); furthermore from Nunarsuatsiaq (belonging to the region of Kangerdluarssuk) by Wynkoop (in Gordon, 7).

	1	2	3	4	5	6	7
SiO_2	43.52	41.78	47.15	43.85	47.08	43.08	49.11
TiO_2	1.73	2.09	—	—	—	0.83	0.78
ZrO_2	0.84	—	—	—	—	—	—
Al_2O_3 ...	5.30	6.32	4.57	4.45	1.34	4.44	1.16
Fe_2O_3 ...	11.12	6.48	10.49	3.80	1.70	8.06	9.23
FeO	22.39	24.84	28.35	33.43	35.65	28.97	25.50
MnO	1.13	1.26	—	0.45	—	0.70	1.13
CaO	2.21	7.63	2.83	4.65	2.32	4.08	0.77
MgO	1.09	2.25	1.19	0.81	—	0.32	0.18
Na_2O ...	7.39	4.41	—	8.15	7.14	5.88	8.01
K_2O	1.83	1.52	—	1.06	2.88	3.28	2.89
H_2O	1.20	1.27	—	0.15	2.08	1.10	1.12
F_2	0.88	—	—	—	—	—	0.29
	100.63	99.85	94.58	100.80	100.29	100.24	100.17
÷ O = 2F	0.37						0.12
	100.26						100.05

Kangerdluarssuk is the oldest known of all the arfvedsonite occurrences. It was found by GIESECKE in 1806, and like ALLAN at a later period he called it hornblende. The name a. was given to it by BROOKE in 1823, and shortly afterwards ARFVEDSON undertook an analysis, the result of which was a composition nearly like that of the hornblende, from which it may be concluded that he has surely made use of this mineral for the analysis. Very doubtful is everything regarding the analysis undertaken by THOMSEN, which agrees well with the composition of a., only excepting that Na is replaced by Mn. As no mineral exists with a composition of this kind, the most likely supposition is that a mistake has been made in the analysis. The analyses undertaken by KOBELL, RAMMELSBERG and DOELTER are mentioned under ægirine; the first analysis undertaken by KOBELL, in 1836, has the correct arfvedsonite-composition (with $36.12^1/_2$ % FeO), but later (in 1864) it is corrected to 23.00 FeO + 14.57 Fe_2O_3. It is doubtful whether the latter values are erroneous, or whether the analysis applies to a mixture of a. and ægirine, as is presumably the case with the analyses undertaken by RAMMELSBERG and DOELTER.

Outside Greenland a. has been found in large quantities in a number of different places.

Qeqertarssuatsiaq, one of the Kitsigsut Øer, possibly identical with Qeqertarssugssuk south of Nanortalik (LAUBE).

LAUBE: Sitzber. d. k. k. Akad. d. Wiss. Wien, 68, 1873, p. 85.

JANOWSKY: Ber. d. d. chem. Ges. Berlin, 1873, p. 1230.

VRBA: Sitzb. d. k. k. Akad. d. Wiss. Wien, 69, 1874, p. 12.

From this locality LAUBE mentions a. in zircon- (or eudialyte-) syenite. Probably it is the same mineral which has been analyzed by JANOWSKY and examined by VRBA; according to the composition it must rather be classed with cummingtonite.

158. Crocidolite. $(Na,K)_2Mg_2\overset{II}{Fe}_5\overset{III}{Fe}_4[(OH)_4Si_{16}O_{44}]$.

The Egedesminde district.

Manîtsoq (GIESECKE). Thin coating of a bluish colour on granite; the fibres extremely fine and closely matted.

The Frederikshaab district.

Arsuk Ø (GIESECKE). A layer about 1 mm thick on a fissure in granite together with albite and rock crystals. The fibres fine, the colour light-blue.

The Julianehaab district.

Tunugdliarfik (GIESECKE 2-8-1809).

USSING: M. o. G. 14, 1898, p. 205.

GIESECKE mentions that at the most westerly river on the northern side of T. in a ravine in which half-disintegrated granite occurs, he found fibrous blue hornblende. This must surely be c. as also stated by USSING.

KORORSSUAQ (GIESECKE).

GIESECKE: Catalogue of Minerals, p. 207.

Mentioned under the name of fibrous iron-phosphate.

Narssârssuk (STEENSTRUP 1888).

USSING: M. o. G. 14, 1898, p. 206.

FLINK: M. o. G. 24, 1901, p. 82.

GORDON: Proc. Akad. Nat. Sci. Phil. 79, 1927, p. 203.

The mineral most frequently forms an irregular matted mass; sometimes the fibrous structure can be seen with the naked eye, but most frequently it is so fine as to give the mineral a microcrystalline or earthly appearance. The colour is light greyish-blue. Owing to the extreme fineness of the fibres it is difficult to determine the angle of extinction; USSING records 5—10°. For pleochroism USSING gives the following scheme: a blue, b greyish-violet, c nearly colourless, whereas GORDON states X methyl-blue, Y straw-yellow, Z pale Medici-blue. Here the two axes seem to have been exchanged, but otherwise it is rather evident that, except by the colour, it is impossible to distinguish them from each other in a material like crocidolite, and that one must thus be content to suppose that the colours of the two axes are orientated in the same manner as in the related minerals arfvedsonite and riebeckite. The crocidolite from N. is as a rule rather impure, mixed with various other minerals and most frequently with a colourless fine-grained substance of an unknown composition.

C. occurs very frequently intermixed with other minerals, in such a manner that it may be supposed to have been produced by alteration of the latter. Thus USSING (see p. 289) describes riebeckite in c.; the fibres lie parallel near the boundary between the two minerals, but farther out their position is quite irregular. FLINK describes c. as an alteration product of ægirine, as it is possible to find direct pseudomorphs after this mineral; in other case the ægirine is found in a parallel position, possibly mixed up with the riebeckite, possibly as an alteration product of the latter, and then in its turn altered into c. GORDON describes and figures arfvedsonite in a parallel position with c.

Very characteristic is a form of the mineral, a few samples of which have been collected by Greenlanders and sent here. They consist of a matted mass of needles, which as far as can be seen are placed in equal quantities in all directions. The individual needles are comparatively thick (about 0.002—0.02 mm) as compared with the otherwise almost invisible single fibres. They are quite rectilinear. The most peculiar

property of the samples is their extreme lightness (specific gravity about 0.4), from which it may be concluded that nine tenths is air. There is no trace of any other substance, nor is it possible to see, how the fibres are connected with each other, but the whole thing is so coherent that a piece may be ground and a microscopical preparation made in the usual manner. An analysis of this special form of the mineral was performed by H. A. NIELSEN with the following result: SiO_2 50.81, TiO_2 1.05, Al_2O_3 0.43, Fe_2O_3 15.61, FeO 20.40, MnO 0.90, MgO 0.92, CaO 0.47, Na_2O 6.56, K_2O 0.52, H_2O 2.07 = 99.74. This composition does not differ very much from that of other crocidolites; as to the proportion between Fe_2O_3 and FeO, the c. in question behaves as that from Rhode Island, whereas that from South Africa possesses most FeO.

The region of Kangerdluarssuk.

Nunasarnaussaq (GIESECKE 20-7-1806). Here mention is made of "verhärtete blaue Eisenerde". The mineral from this locality consists of closely matted masses together with felspar.

Redekammen (GIESECKE 1806).

GIESECKE: Catalogue of Minerals, p. 204.

Recorded as fibrous blue iron-phosphate; identical with it is possibly a large loose block, found in 1900 by USSING in Lakseelven near Redekammen. The block consisted of rather pure c. enclosing a number of large blue quartz grains. The fibres are fairly parallel, the colour is light greyish-blue.

Qingua Tasermiut (HARTZ 1889). In the moraines of the Inlandice a sample of c. was found, which was of the usual consistency of confused fibres, with enclosed areas of granular siderite. The colour a strong greyish-blue.

159. Kaersutite. $(Na,K)_{2-3}Ca_4Mg_{4-6}Fe_{1-3}Ti_{0-2}(\overset{III}{Fe},Al)_{2-3}[(O,OH)_4 Al_4Si_{12}O_{44}]$.

The Umanak district.

Østerfjeld near Qaersut (GIESECKE 26-6-1811).

LORENZEN: M. o. G. 7, 1893, p. 27.

USSING (in ROSENBUSCH: Mikr. Phys. Vol. 1, pt. 2, 1905, p. 236.

WASHINGTON: Amer. Journ. Sci. 26, 1908, p. 192.

ARNOLD HEIM: M. o. G. 47, 1911, p. 210.

COSSNER and SPIELBERGER: Zts. Krist. 72, 1930, p. 120.

Found in veins of up to 20 m thick in peridotite. K. makes somewhat less than half of the veins, the remainder consists of a labradorite, besides smaller quantities of various other minerals, among those also various kinds of augite. K. forms long thin prisms (length up to 5 cm, width up to 5 mm); as a rule they are irregularly orientated, but they

may also sometimes be placed at right angles on the border of the vein. The crystals are bounded by (110), further by (011) and more rarely by (101) and (010). Twin formations of rather common occurrence in microscopic sections.

The specific gravity is 3.04 (LORENZEN), 3.237 (USSING), 3.137 (WASHINGTON). The hardness is $5^1/_2$—6. The colour is black with a brown streak; pleochroism: c dark red-brown, b nearly the same, a light-brown. Obliquity of extinction about 10°. Refraction indices (WASHINGTON) α 1.676, β 1.694, γ 1.708, of which 2 V = 82°6′. Analyses undertaken by LORENZEN (1), WASHINGTON (2), GOSSNER and SPIELBERGER (3):

	1	2	3
SiO_2	41.38	39.30	39.50
TiO_2	6.75	10.25	10.33
SnO_2	0.26	none	none
Al_2O_3	14.41	11.16	11.12
Fe_2O_3	none	1.21	0.06
FeO	11.28	8.76	9.44
MnO	n. d.	0.06	0.10
NiO	n. d.	none	none
MgO	13.51	13.24	12.90
CaO	12.97	11.29	10.91
Na_2O	n. d.	2.93	3.82
K_2O	n. d.	1.06	1.43
H_2O	n. d.	0.59	0.59
P_2O_5	n. d.	0.32	none
	100.56	100.17	100.20

LORENZEN considered k. an independent mineral, which was named after the locality, but later on it has chiefly been regarded as a variety of hornblende. As recent Röntgen-investigations show a close relationship with arfvedsonite and barkevikite, the independence of the mineral must be regarded as established.

Outside Greenland the mineral has been found on the island Linosa south of Sicily.

Slibestensfjeld, near the former coal-mine of Qaersuarssuk (HEIM and RAVN 1909).

HEIM: M. o. G. 47, 1911, p. 215.

RAVN: ibid. p. 167.

As in the former occurrence k. is found in picrite dykes; the crystals of k. are much smaller than those from the former locality, but, according to the description of HEIM, both are in all respects quite similar, excepting only of the obliquity of the extinction which is found to be 12—16°.

In different other peridotite- (picrite-) veins found in the peninsula of Nûgssuaq there is no k. seen.

160. Barkevikite. $(Na,K)_{2-3}Ca_4Ng_{4-6}Fe_{1-3}Ti_{0-2}(Fe,Al)_{2-3}[(O,OH)_4Al_4Si_{12}O_{44}]$.

The Julianehaab district.

Narssârssuk Steenstrup 1888.

Ussing: M. o. G. 14, 1898, p. 210.

Gordon: Proc. Akad. Nat. Sci. Phil. 79, 1927, p. 204.

From the pegmatite veins in the augite-syenite Ussing describes larger individuals of an amphibole, which macroscopically is black with a greenish-brown streak. The absorption colours: a light-brown, b greyish-brown, c green. The angle of extinction is 15°, and it cannot be decided whether it turns forwards or backwards. Gordon states that there is some b. "or even cataphorite" (catophorite?) together with arfvedsonite and crocidolite. Nothing is said of the appearance of this b. but the following data are given: angle of extinction 15°, $\alpha = 1.670$, $\beta = 1.680$, $\gamma = 1.685$? pleochroism strong: X reed-yellow, Y olive-brown, Z olive-yellow to greenish-olive. An analysis was undertaken by A. H. Nielsen with the following result: SiO_2 44.96, TiO_2 2.33, Al_2O_3 3.80, Fe_2O_3 5.23, FeO 26.04, MnO 1.14, MgO 2.55, CaO 6.37, Na_2O 5.16, K_2O 1.47, H_2O 0.86 = 99.91. These values correspond rather well with the analyses of the Norwegian b. but as these differ rather much from eachother, we cannot expect a closer identity of the above analysis with any of them. On the other hand the analysis stands much farther from those of all other amphiboles.

As to the occurrence of b. together with riebeckite etc. see this mineral.

Kangerdluarssuk (Steenstrup 1888).

Ussing: M. o. G. 14, 1898, p. 210.

In the augite-syenites a mineral is found, which greatly resembles the preceding one, the absorption colours however being somewhat browner: a light-brown, b very dark-brown, c brown with a faintly greenish tinge. The optical orientation as at the preceding from the above-mentioned locality; the mineral frequently found in parallel intergrowth connection with a pyroxene.

In the arfvedsonite granites a similar mineral is found with more greenish absorption colours; the angle of extinction is about 15—25°.

In both rocks the barkevikite-like mineral is frequently grown together with an amphibole, which is something between arfvedsonite and riebeckite and has been mentioned under the latter mineral.

More differing from the preceding varieties is a mineral which rather belongs to an arfvedsonite-barkevikite-series. It is found in nepheline-syenite from Naujakasik together with ægirine and ænigmatite. The angle of extinction is 30—40°, and as in arfvedsonite it

is *a* which is nearest the *c*-axis. The absorption colours are most frequently: a dark-green, b dark-greyish-brown, c paler greyish- or greenish-brown.

161. Hornblende. $(Na,K)_{0.5\text{-}2}Ca_{3\text{-}4}Mg_{3\text{-}8}\overset{II}{Fe}_{2\text{-}4}(Al\overset{III}{Fe}_2[(OH)_4 Al_{2\text{-}4}Si_{14\text{-}12}O_{44}]$.

The Umanak district.

Anoritoq (Rink).

Rink: Ngr. p. 42.

Large crystal individuals (up to 8 by 4 cm) together with anthophyllite and biotite; most frequently a very strong parting parallel with (100). The colour brownish-black, in thin splinters brown, without distinct pleochroism.

The Jakobshavn district.

Pâkitsoq. Coarse-grained mass without other minerals. The colour black, in translucent light impurely greenish without a distinct pleochroism.

The Christianshaab district.

Nûk (Sylow 1883). Coarse-grained masses without connection with other minerals excepting a small quantity of biotite. The colour brownish-black, in thin splinters also brownish with an indistinct pleochroism.

The Egedesminde district.

Qaqarssuit within Egedesminde (the Rev. Sørensen 1900). On a very fine-grained mica-schist which almost exclusively consists of quartz and brown mica, there are, besides numerous garnet crystals, also very numerous small (about 1 cm long) crystals of hornblende; they have very shining faces of (110). The colour is black, in thin sections green, with strong pleochroism of the usual kind.

Iginiarfik (Vibæk 1906). Together with the green diopside (p. 269) crystals of an amphibole of almost the same emerald-green colour are found, often, however, somewhat darker; the size is up to 1 by 1 by 0.5 cm. The crystals are rather imperfectly developed; besides the faces of (110) sometimes narrow faces of (100) and (010) are seen; no terminal faces. The mineral is also found as quite thin lamellae parallel (100) in the pyroxene. The pleochroism rather strong: a and b green, c brownish. It is well-known that most of the amphiboles have the greenish colours in the longitudinal direction, but also exceptions are known. In particular attention should be called to the pargasite from Fiskenæsset, which is mentioned below and the pleochroism of which agrees entirely with the above. Thus there is a possibility that the mineral in question may also

be pargasite, but this mineral can hardly be distinguished from actinolite except by a chemical analysis.

The Sukkertoppen district.

Siorarssuit (GIESECKE 11-7-1808).

RØRDAM: M. o. G. 8, 1889, p. 125.

Found as quite small (less than 1 mm) elongated grains in olivine. GIESECKE who calls the locality Sandhullet (ɔ: the sand hole) names the mineral smaragdite, which is closely related with actinolite, whereas RØRDAM calls it green hornblende (grammatite), this name otherwise used as a synonym for tremolite. Under the microscope the grains have a pure, green colour; pleochroism with the croswise moving rays more vividly green than those moving lengthwise, as was the case at Iginiarfik.

The Godthaab district.

Narssatsiaq (GIESECKE 10-8-1808). Rather large individuals in pegmatite together with biotite and smaller quantities of actinolite. The colour black. In thin splints brownish-green with the usual pleochroism.

Fiskenæsset.

DESCLOIZEAUX: Manuel de Minéralogie 1, p. 462.

LORENZEN: M. o. G. 7, 1893, p. 22.

USSING: Zts. f. Kryst. 15, 1889, p. 613. Öfv. k. Vet.-Akad. Förh. 1889, No. 1.

Found in a sapphirine-bearing rock together with gedrite, mica and secondarily iolite, anorthite and kornerupine. The h. is one of the last formed of these minerals.

Two different varieties occur; one is greyish-yellow in colour; specific gravity 3.08 (DESCLOIZEAUX), 3.06 (LORENZEN), 3.052 (USSING). The second variety, which USSING subjected to a closer investigation, is emerald-green in colour; it is found in regularly shaped grains, only rarely with (110) developed; the cleavage angle is measured at 55°42′. The obliquity of extinction is 16°, the birefringence positive. The axial angle 2 V is 82°36′ in red light. Refraction index β is 1.638. Pleochroism strong: a and b emerald-green, c light-brownish. Specific gravity 3.07 (LORENZEN), 3.064 (USSING). Analysis undertaken by LORENZEN: SiO_2 46.79, Al_2O_3 15.36, Cr_2O_3 0.69, FeO 2.38, CaO 13.11, MgO 20.17, loss at ignition 2.13 = 100.63.

DESCLOIZEAUX called the mineral tremolite, LORENZEN named it edenite, and only Ussing proved it to be pargasite.

"Fiskenæsset District", without specified locality (RINK). This is a single fragment of a rather peculiar nature; the hornblende occurs as a kind of phenocryst up to 3 cm in length in a fine-grained eclogitic

rock, consisting of garnet, enstatite and smaller quantities of a light uniaxial mica, possibly phlogopite. The hornblende is of a strong greenish colour, which has a very striking effect in the red ground-mass; in all respects, also by its peculiar pleochroism, it agrees with the just mentioned mineral from Fiskenæsset and must probably be a pargasite. The manner of occurrence for the two minerals, however, show such essential differences that they can hardly have anything to do with one another.

The Julianehaab district.

Narssârssuk.

FLINK: M. o. G. 14, 1898, p. 229.

The h. mentioned here has, by later examinations, proved to be riebeckite. In the same treatise (p. 242) mention is made of hornblende-like yellow and white prisms, which have later been proved to be rinkite and apatite.

Statenhuk or Kangeq Qujadtleq.

LEONHARD: Handbuch d. Oryktognosie, 1821, p. 531.

Here mention is made of h. with felspar and garnets.

162. Anthophyllite. $(Mg,Fe)_7[OHSi_4O_{11}]_2$.

A. is found in a number of localities in Greenland, both in an asbestus-like form and as thicker prisms. As the mineral can hardly be distinguished from the following, i. e. gedrite, without a chemical analysis, it is naturally possible that some of the occurrences may be this mineral. As the gedrite is the rarer mineral of the two, only such occurrences have been referred to the latter, of which analysis exists, and a few which are very close to them.

The Umanak district.

Between Itivdlinguaq and Sermilik (RINK).

RINK: Ngr. p. 42.

It is recorded that in the entire quantity of rock in this locality there are extensive layers of fine-grained a. in a white ground-mass; however, the mineral in question, like the one from the actual dwelling-place I. by RINK named a. is in reality bronzite.

Akugdlît (GIESECKE 26-4-1811). The mineral which GIESECKE calls schiller spath, consists of a granular aggregate (size of grains 1—3 cm), every single grain rather consists of somewhat irregular, fibrous mass. The substance impure, brownish.

Ũmánatsiaq (GIESECKE 29-4-1811). Found in gneiss in the form of long prismatic crystals (up to 1 dm in length) or columnar aggregates. The colour is dark-brown.

Akuliaruseq (GIESECKE). Asbestus-like, fibrous masses in a fine-grained mixture together with light-green actinolite prisms; the colour brownish-white.

The Godhavn district.

Fortunebay (O. R. B. Hansen 1937). Close to the shore, apparently imbedded in gneiss fragments of a mass consisting of a mixture of asbestus-like a. and quartz. The two minerals are greatly intermixed, though in rather an irregular manner, parts with a pure or nearly pure a. interchanging with others of almost pure quartz. A. is of a brownish-white colour; the colour of the quartz is greyish, and under the microscope it proves to be penetrated by numerous isolated asbestus-fibres with a somewhat irregular course.

The Christianshaab district.

Eqaluit, southern side of — (Rink). Radiating aggregates together with biotite, garnet and hornblende; the single individuals are up to 1 dm long, frequently curved; the colour is lighter or darker brownish.

Kangerdluluk (Giesecke 2-10-1807). Thin prisms (length 1—2 cm) in actinolite-schist; the bounding irregular, the colour brownish. From the same locality the mineral which Giesecke called amianth also occurs; it consists of asbestus-like a., very similar to that mentioned from Fortunebay.

Nûk (Giesecke 1807, Rink, Sylow). The large material collected at various times all contains asbestus-like a. of a whitish colour. A few varieties are easily separated from each other in very regular, rectilinear fibres.

The Egedesminde district.

Hareø. Irregularly shaped masses (1—3 cm) together with mica and actinolite; the colour light-brown.

The Holsteinsborg district.

Ikertôq (Lassen 1876). Rather fine asbestus-like, but so continuous that the fibres can only with difficulty be separated from each other. The colour light-brown.

Sarfanguaq (Søren Hansen). Fine asbestus-like fibres on enstatite and partly intergrown with the latter.

Maligissap Kava, about 6 km north of the eastern end of Sarqaq's Kangerdluarssuk (the Bernburg expedition, 1903).

Ball: M. o. G. 63, 1923, p. 56.

This is undoubtedly the largest asbestus occurrence in Greenland, and possibly the one to which Hans Egede refers when speaking of quantities of this mineral[1]) or even actual mountains of it[2]). The asbe-

[1]) Omstændelig og udførlig Relation etc. 1738, p. 132.

[2]) Det gamle Grønlands Nye Perlustration etc. 1741, p. 26.

stus is found in fissures in dunite in the form of lenses; the regular parallel fibres in the middle of the lenses attain a length of about 0.7 m, while near the boundary plans small octahedrons of chromite are found. Large quantities of those have been sent to the Mineralogical Museum of Copenhagen the largest specimen attaining a length of 61 cm and a weight of 17 kg. The asbestus is brownish-white in colour and unusually pure. The individual fibres are, however, most frequently rather brittle, and it is impossible to detach long fibres; in some cases the mass is also rather continuous.

The Sukkertoppen district.

Kangerdlugssuaq (Langskov 1917). A rather large fragment of pure asbestus of a whitish colour. The fibres unusually fine, but as in the preceding occurrences too closely interwoven to be easily separated from each other.

Kûgssuaq in Kangerdlugssuaq (J. A. D. Jensen 1884).

Jensen: M. o. G. 8, 1898, p. 57.

Here mention is made of talc in connection with actinolite and asbestus. Both of the latter are anthophyllite, occurring in a columnar as well as in a fine-fibred form. The fibres are not easily separated. This occurrence is possibly identical with the preceding one.

The Godthaab district.

Naujanguit (Giesecke 1808). Coarse-grained aggregate consisting of a. with a little biotite. The colour brown, the mineral not asbestus-like.

Alangorssuaq (Giesecke 1808). Coarse-fibred aggregates, partly brownish and partly of a greyish-green colour rather rare in a.

Narssatsiaq (Giesecke 1808). Coarse-fibred together with actinolite.

Bjørneø (ɔ: bear island) (Giesecke). Found in several forms, among which irregularly shaped areas in a fine-grained rock; besides as a coarsely columnar aggregate with numerous small mica-leaves.

Kôroq (Giesecke 1810).

Laube: Pogg. Ann. 35, 1835, p. 486.

The mineral described in these works is a white coloured asbestus-like a. with silky gloss and fibrous structure; the single fibres are not very pliable, the mineral is heavily fusible. Analysis: SiO_2 58.48, FeO 9.22, MgO 31.38, CaO 0.04, MnO + CuO + Al_2O_3 + P_2O_5 + loss 0.88 = 100.00.

Hjortetakken (Giesecke Sept. 1808). Asbestus-like, silky together with enstatite. The colour brownish-white.

Itivnera (J. A. D. JENSEN 1885). Very fine and soft asbestus, the fibres of which are easily detached, but rather brittle; the colour brownish-white. As to the occurrence nothing is known. Similar fragments have been given to Dr. BOBÉ at Ameralik by Greenlanders; probably they originate from the same locality.

Aliortoq (GIESECKE 1808). Found both in an asbestus-like form and as a radiating aggregate.

Qarajat (GIESECKE 1808, FÆSTER 1937). GIESECKE's material for the greater part consists of radiating and fibrous aggregates, mixed with actinolite, also sometimes in rather pure asbestus-like specimens; further, fine asbestus fibres are found intergrown with large biotite crystals. The material collected by FÆSTER consists of small elongated crystals of the two minerals, found in large quantities in a biotite-schist.

Aunikasik (FÆSTER 1944). Occurs as thin, light-coloured striae in the large individuals of enstatite (p. 278). These striae are arranged parallel with the *c*-axis of the enstatite; the structure fine-fibred, asbestus-like. There are also scattered areas in the olivine accompanying the enstatite (p. 187). Here naturally no parallel orientation is found.

Fiskenæsset.

LORENZEN: M. o. G. 7, 1893, p. 24. (The treatise probably from 1883).

USSING: Zts. f. Kryst. 15, 1889, p. 614.

From this locality LORENZEN mentions a kuppferite, (i. e. a.) containing great quantities of magnesia. USSING has proved the material in question to be bronzite.

Îkátoq (GIESECKE 1809).

LEONHARD: Handbuch d. Oryktognosie, 1821, p. 432.

KORNERUP: M. o. G. 1, 1879, p. 84.

Found in thin prisms in a light-coloured fine-grained rock, which chiefly consists of oligoclase. The prisms are in part arranged in sheat-shaped groups. They are bounded by *m* (110), which is very irregularly striated. The colour dark-brownish.

The Frederikshaab district.

Qeqertaq (RINK). Asbestus-like, mixed with bronzite, without a parallel intergrowth, but rather in many cases with *c*-axis placed cross-wise of each other in the two minerals. The colour light-brown. No other minerals are seen, and nothing is known as to the occurrence.

East-Greenland.

Paornakajît in Sermilik (RÜTTEL 1902, EINAR MIKKELSEN 1946). The occurrence is described p. 279: the a. is formed as large radiating

groups which most frequently enclose large enstatite crystals and mica-leaves, the asbestus-like a. being reduced to a few fine needles extending between the other minerals. The asbestus itself is very fine and easily dissoluble, the colour is light-brown.

Íkáteq in Sermilik (Einar Mikkelsen 1945). Slightly southeast of I. asbestus-like a. has been found, partly quite pure, partly with embedded lenses of chlorite; the colour light-brownish, the fibres can only to a slight extend be separated from each other.

Greenland without a definite locality.

Descloizeaux (Nouvelles recherches etc. 1867, p. 32) mentions that Breithaupt presented him with some specimens of a Greenland mineral which he considered new, and for which he proposed the name Thalackerite. However, the investigations undertaken by Descloizeaux proved the mineral to have the properties of the anthophyllite; cleavage after (110) with an angle of 124°40′, a brown colour and vitreous lustre on (100); less distinct with a golden colour and metallic lustre on (010); optical orientation as in a.; the optic axial angle ($2H_0$) determined at 117°35′; the specific gravity somewhat less than usual. Descloizeaux considers the mineral to be a variety of a.; it is impossible with certainty to identify the latter with any of the known Greenland occurrences.

163. Gedrite. $(Mg,Fe)_6(Al,Fe)[OH(Si,Al)_4O_{11}]_2$.

As to the relation between this mineral and anthophyllite see under the latter mineral; in the following only the two occurrences are referred to g. from which analyses occur, and a couple of others which are surely very closely related to them.

The Godthaab district.

Qoroq (Giesecke 6-6-1810). Here mention is made of a labradorizing hornblende which is not nearly so pronounced as the one from Auvaitsersarfik; probably it is like the other one gedrite.

Kasigianguit at Godthaab (Giesecke 17-7-1810). Found as prismatic grains (1—2 cm) in pegmatite. Colour and play of colours nearly as in the mineral from the following locality, for which reason the mineral may presumably also be gedrite.

Auvaitsersarfik (Giesecke 1.6.1810).

Leonhard: Handwörterbuch d. topogr. Mineralogie, 1843, p. 22.

An occurrence which judging by the samples at hand is rather interesting. The main mass of g. occurs as rather large, irregularly formed individuals (up to 8 cm) together with biotite, quartz, labradorite and sometimes garnet. The leaves of the biotite are frequently

intergrown with the gedrite, parallel with the prism faces of the latter. In a few samples an entirely different combination is found, i. e. besides g. and mica, reddish-white corundum, a black nearly quite untransparent mineral, possibly an iron-spinel and finally small grains of sapphirine. Finally, there are gedrite crystals of up to 1 cm in size in labradorite crystals, intergrown with larger garnet crystals. Form: (100), (010) and (110); no terminal faces; the faces well-developed, shining.

The greater part of the gedrite is black-grey, sometimes showing a strong blue reflection most frequently in the direction of (010); parallel with this face is also a faint parting. The specific gravity is determined at 3.196; the mineral is optically positive; a (= *a*-axis) is the obtuse bisectrix; the obtuse axial angle ($2H_0$) is 117°, of which may be calculated $2V_a$ = about 76°. The refraction in the longitudinal direction is very near 1.658. The pleochroism rather strong: a greyish-yellow. b yellowish, c dark violet-grey. Analysis undertaken by Chr. Christensen: SiO_2 50.37, Al_2O_3 10.82, FeO 15.89, MgO 19.75, CaO 0.84, Na_2O 1.59 = 99.26.

Giesecke named the mineral "labradorisierende Hornblende", but in the later lists of his collections it is recorded as hypersthene.

Fiskenæsset (Steenstrup 1877).

Ussing: Zts. f. Kryst. 15, 1889, p. 609. — Öfvers. k. Vet.-Akad. Förh. Stockholm, 1889, No. 1.

Found in the sapphirine-bearing rock together with mica, hornblende and sometimes iolite, anorthite and kornerupine. Small colourless grains or short prisms, which in a few cases may attain a width exceeding 1 cm; (110) is seen to be well-developed on these large individuals, sometimes also (100); the prism angle is 55°12′, the specific gravity 3.100. The mineral is colourless or faintly brownish without pleochroism; optically positive, the optic axial angle 2 E is 78°33′. Refraction indices for red: $\alpha = 1.623$, $\beta = 1.636$, $\gamma = 1.644$. Analysis undertaken by Ussing: SiO_2 46.18, Al_2O_3 21.78, Fe_2O_3 0.44, FeO 2.77 MgO 25.05, Na_2O 2.30, H_2O 1.37 = 99.89.

Asbestus.

A. is not an independent mineral, but fibrous varieties of different silicates. Judging by its physical properties, and more especially by its parallel extinction most of the Greenland a. belongs to anthophyllite; less common is a. belonging to tremolite, actinolite, serpentine or crocidolite. The individual localities will be found under the said minerals. Although from the first colonization of the country a. has greatly attracted the attention of those exploring the country, no practical application has as yet been found for it, whether because the occurrences are too small, or because it is not sufficiently easy to separate the fibres from each other, or also because they are too brittle.

164. Ænigmatite. $(Na,Ca)(\overset{II}{Fe},Ti,Al,\overset{III}{Fe})_5[O_3Si_4O_{11}]$ (?).

The Julianehaab district.

Narssârssuk. The mineral is not with certainty known from this locality, but in 1908 the Mineralogical Museum of Copenhagen received a sample collected by Greenlanders, and it was sent in together with minerals from N. It might naturally be supposed that the collector in question had brought the sample with him from Kangerdluarssuk, but in its habito the sample bears so little resemblance to the usual æ., that this supposition is hardly probable. It is a single, rather large specimen (largest dimension 7 cm) without connection with other minerals, and it seems extremely pure and fresh; the fracture is shining and black, in most cases conchoidal, but in places it also shows excellent cleavage planes. There is a great similarity between this æ. and the formerly (p. 291) described arfvedsonite from the same locality, though naturally with the exception that the cleavage faces are far more pronounced in this mineral. The cleavage angle is determined at 66°55′ (theoretically 65°51′), the specific gravity at 3.851 (former determinations at 3.74—3.85). The analysis is given below.

The region of Kangerdluarssuk.

Breithaupt: Berg- u. hüttenm.-Zeits. 1866, reprint, p. 50.
Lorenzen: M. o. G. 2, 1881, p. 53.
Brøgger: Geol. Fören. Förh. Stockholm, 9, 1887, p. 270.
Brøgger: Zts. f. Kryst. 16, 1890, p. 423.
Ussing: M. o. G. 14, 1898, p. 214.
Gossner and Mussgnug: Centralbl. Min. etc. 1929 A, p. 5.
Gossner and Spielberger: Zts. Krist. 72, 1930, p. 127.
Palache: Zts. Krist. 86, 1933, p. 283.
Fleischer: Amer. Journ. Sci. 5. Ser. 32, 1936, p. 343.

Found as a constituent of the nepheline-syenite and more particularly in the pegmatitic veins; it seems that it occurs rather abundantly at the localities Naujakasik and Tuperssuatsiaq on the southern side of Tunugdliarfik, where it is possible to collect numerous crystals, loosened by the decomposition of the rock. Æ. is one of the first formed minerals, for which reason the crystals are, for the greater part, bounded with rather numerous faces, but as a rule they are interrupted by other minerals; in the interior ægirine is particularly often found in orientated intergrowth with the ænigmatite. The crystal faces are nearly always quite dull and the fractures irregular as distinguished from what is the case in æ. from Narssârssuk. The crystals are as a rule elongated parallel with the *c*-axis, and the length varies from 2 to 8 cm, the width attaining about 5 cm. The crystals have been investigated by Brøgger,

who found the following faces: (100), (010), (1$\bar{1}$0), (110), (130), (1$\bar{3}$0), ($\bar{1}$01), (011), (0$\bar{1}$1), (031), (0$\bar{3}$1), (051), (0$\bar{5}$1), ($\bar{1}$21), ($\bar{1}\bar{2}$1), ($\bar{4}\bar{3}$3).

There is a rather strong cleavage parallel with (110) and (1$\bar{1}$0); the colour is black, the streak dark-brown. Only thin splinters are transparent with brown colour and strong pleochroism: α light reddish-brown, β chestnut-brown, γ deep brown-black. Optically positive, the axial angle 2 E = 59°. The average refraction is about 1.80, birefringence 0.006. Hardness 5.5, specific gravity 3.833—3.865 (Breithaupt), 3.80 (Lorenzen). Analyses have been undertaken by A. H. Nielsen (1, on the mineral from Narssârssuk), Forsberg (in Brøgger, 2) and by Gossner and Spielberger (3, mean of two analyses).

	1	2	3
SiO_2	38.29	37.92	39.46
TiO_2	8.09	7.57	7.78
Al_2O_3	2.21	3.23	4.20
Fe_2O_3	6.16	5.81	3.04
FeO	35.81	35.88	39.24
MnO	1.04	1.00	0.63
CaO	0.61	1.36	2.42
MgO	1.24	0.33	0.19
K_2O	0.06	0.51	0.11
Na_2O	6.43	6.58	3.30
H_2O	tr.	—	0.32
	99.94	100.19	100.69

In analysis 1 a search was made for ZrO_2, F and V_2O_3, however, without any result. As it appears the three analyses agree almost perfectly with each other, though the composition is so complicated, that it is almost impossible to give any probable formula for the mineral.

By blowpipe the æ. melts easily to a brownish-black glass; it is only with difficulty dissolved in acids.

The mineral was for the first time described by Breithaupt, who for it formed two new names of minerals, ænigmatite (from enigma of Greek or Latin derivation) and kölbingite named after a certain Mr. Kölbing in Hernhut, who had presented Breithaupt with the material. The kölbingite has the following properties: the colour greenish-black with a pistaccio-green streak; the crystal form triclinic, complete cleavage parallel with two faces forming an angle of 66°31′; hardness $7^1/_2$—$7^3/_4$, specific gravity 3.519—3.613. Breithaupt supposed æ. to be a pseudomorph after kölbingite, Lorenzen maintains that æ. cannot be a pseudomorph, but described it as monocline. Brøgger undertook a more detailed investigation of the material, thus establishing its physical and chemical properties; he rather supposed that the kölbingite must consist of æ. and arfvedsonite in parallel connection. Ussing who

obtained a crystal from BREITHAUPT's material for examination proved that k. consisted of æ., on the outside coated with ægirine, which sufficiently explains the above-mentioned properties of the mineral. The more recent investigations aim at the examination of crystal structure, chemical formula etc., and as to this the reader is referred to the treatises quoted. It seems, however, to be sure that æ. should not, as in former times, be classed with the amphiboles as a triclinic link, but must be said to stand rather isolated in the system.

Outside Greenland æ. has been found in great quantities in Russian Lappland; a closely related mineral, cossyrite, has been found as small, beautiful crystals on Pantellaria, whereas another related mineral, rhönite has been found in Hessen.

165. Eudidymite. $Na[BeSi_3O_7OH]$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 230.

FLINK: M. o. G. 24, 1901, p. 56.

E. which in many respects bears a great resemblance to the following mineral has been found lying in rather large quantities in the gravel, either alone or also in connection with several of the minerals characteristic of the occurrence, more particularly epididymite. Like the fol-

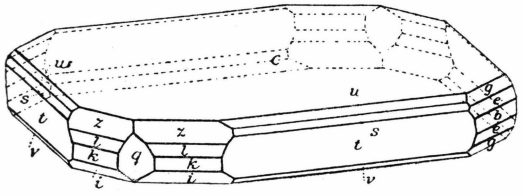


Fig. 61. Eudidymite. Narssârssuk. (After FLINK).

lowing the mineral only occurs crystallized in crystals, some of which rather abound in faces; the form of the crystals is that of flat tabulae with a rhombical outline, as appears from fig. 61, which is bounded by the following forms: c (001), b (010), q ($\bar{5}01$), e (0.10.3), g (053), t ($\bar{5}51$), v ($\bar{3}34$), s (552), u (335), l (310), z (15.5.3), k (15.5.3), and i ($\bar{6}25$). Twin formations are found, exclusively with twin planes (001) which appear as thin lamellae grown into the main individual.

Strong cleavage, parallel with c, less in the direction of ($\bar{5}51$); hardness 6, specific gravity 2.553. E. is colourless and transparent. Optically positive. The axial plane parallel with b. The acute bisectrix forms together with the c-axis an angle of $-58°30'$. Refraction: $\alpha =$

1.5453, $\beta = 1.5457$, $\gamma = 1.5508$; the axial angle 2 V is 29°19′, all with yellow light. E., like also epididymite melts easily before the blow-pipe into colourless glass; they dissolve with difficulty and incompletely in HCl; the water first vanishes entirely in a high temperature.

The Greenland crystals are composed of plates, grown together fan-wise with parallel *b*-axes. It is very characteristic that many of the elongated epididymite crystals have often become coalesced with the large basic faces of the eudidymite, the faces of both minerals of (001) being parallel, and that the longitudinal direction of the epididymite crystals is parallel with the zone *c-u-s-t-v* in eudidymite.

166. Epididymite. *Na[BeSi$_3$O$_7$OH]*.

The Julianehaab district.

Narssârssuk (Lytzen's Collection 1893).

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 201. — Zts. f. Kryst. 23, 1894, p. 353.

G. Nordenskiöld: Geol. Fören. Förh. Stockholm, 16, 1894, p. 345.

Flink: M. o. G. 14, 1898, p. 230.

Flink: M. o. G. 24, 1901, p. 61.

Bøggild: M. o. G. 33, 1907, p. 105.

Gossner und Mussgnug: Festschrift Victor Goldschmidt, 1928, p. 117.

E. crystallizes rhombically and pronouncedly pseudohexagonally with a prism angle very close to 60°. The mineral is only found as

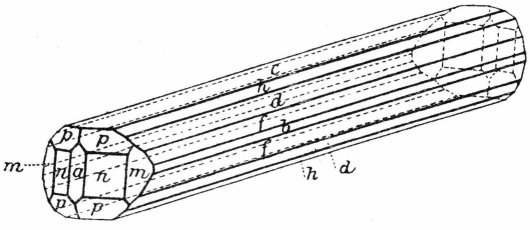


Fig. 62. Epididymite. Narssârssuk. (After Flink).

crystals, which are most frequently very well-developed and rich in faces. There are several different types among which special emphasis should be put on those represented by fig. 62 which is by far the most common form with the faces: *a* (100), *b* (010), *c* (001), *m* (110), *n* (310), *f* (021), *d* (011), *h* (038) and *p* (311). These crystals are often penetration twins or trillings, forming angles of 60° with each other. Other forms are, besides being elongated along the *a*-axis, also flattened parallel with (001). A particularly beautiful and characteristic form, of which

in the course of time rather numerous and large specimens have been produced, is shown on fig. 63; here the pseudo-hexagonal appearance is particularly distinct. A number of other faces occur which, however, will not be mentioned here.

Very strong cleavage parallel with (001), somewhat fainter along (010); hardness 5.5, specific gravity 2.548. Optically +, the axial plane parallel with (001), $Bx_a \perp (010)$. With yellow light $\alpha = 1.445$, $\beta = 1.544$, $\gamma =$

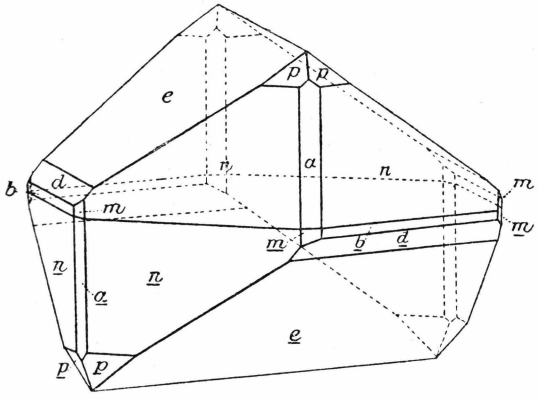


Fig. 63. Epididymite. Narssârssuk. (After Flink).

1.546, birefringence thus very small, axial angle 2 V is 31°4′. Analysis undertaken by Flink: SiO_2 73.74, BeO 10.56, Na_2O 12.88, H_2O 3.73 = 100.91. This composition yields the formula $HNaBeSi_3O_8$, which is identical with that of the eudidymite, for which reason the name is also formed in agreement with this mineral, at that time only known from Norway. Since then the epididymite has also been found in Norway, in the same manner as the eudidymite has been found in Greenland.

167. Melilite. $(Ca,Na)_2[(Al,Mg)(SiAl)_2O_7]$.

The Frederikshaab district.

Frederikshaabs Isblink (Holst 1880).

Törnebohm: Geol. Fören. Förh. Stockholm, 6, 1883, p. 705.

Found as a principal constituent in a melilite basalt which in addition contains olivine, mica and also secondarily perovskite, magnetite and calcite. M. forms small tabulae (up to 0.35 mm) with a distinct cleavage parallel with base and deep-blue interference colours.

168. Leucophanite. $(Ca,NaH)_2[BeSi_2O_6(OH,F)]$.

The Julianehaab district.

Narssârssuk. In the years immediately after 1905, the Greenlanders sent in a great quantity of minerals from this locality, and among

those there were also a few crystals of 1. That they originate from the actual locality N. can with certainty be concluded from the fact that they are intergrown with the fibrous form of astrophyllite characteristic of N.; besides a great amount of ægirine is found in the samples. The form of the crystals is very different from what is otherwise known in the mineral, especially also from the Kangerdluarssuk specimens,

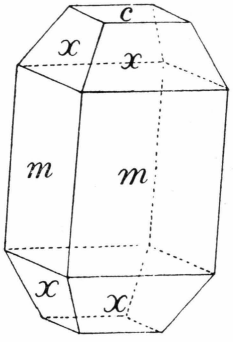


Fig. 64. Leucophanite. Narssârssuk.

and very simply composed. They form prisms of a length up to 1 cm and a width of up to 5 mm, exclusively bounded by the faces *m* (110), *c* (001), and *x* (221), as shown on fig. 64. The faces are rather dull and yield very faint reflexes, which has some bearing upon the fact that the crystals are greatly intermixed with foreign material at the surface, where the colour is also white, whereas the interior is clearly transparent and yellowish. All the crystals are twins with a twin plane (110); how-

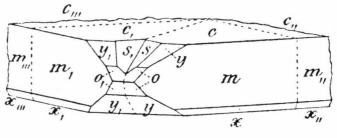


Fig. 65. Leucophanite. Kangerdluarsuk.

ever, the twin formation is not visible from the outside, but in sections parallel with the base quite irregular twin boundaries are very conspicuous, when a gipsum-leaf is inserted.

Kangerdluarssuk (Steenstrup 1899). Small crystals (1—5 mm) picked out of the sodalite syenite; of accompanying minerals there are only very small ægirine and astrophyllite crystals. The crystals are developed as shown by fig. 65 (somewhat schematized); the faces observed are *c* (001), *m* (110), *y* (101), *o* (201), *s* (223), *x* (221). They are very different in character; c. is always very irregular, curved with grooves and furrows; however, in the goniometer it gives a fairly good reflection

from which striae radiate in the direction of *m* and *y*. Most of the other faces are plane and shining, only *s* is strongly curved; it is always only found in a re-entrant angle.

There are twins along (110) and (010); the former is not visible from the outside but can be observed in sections, the optic axial planes being orientated at right angles in the two individuals; the other kind of twins, on the other hand, is visible by means of their re-entrant angles.

Most frequently only one corner is developed as shown on the figure. The physical conditions are in all essentials as those of the Norwegian mineral; the colour is greenish-yellow or greyish-white. The crystals clear and transparent; the specific gravity 2.968, the optic axial angle, 2 E, is 75°.

Besides from the two Greenland occurrences 1. is only known from the Langesundsfjord in Norway, where it is found in far greater quantities and has been known from 1840. Further it is found on Kola.

169. Apophyllite. $KCa_4[F(Si_4O_{10})_2]\ 8\,H_2O$.

The Upernavik district.

Sukaussat (Rink). Crystals (up to 5 mm) together with chabazite in basalt. Forms: (100), (001), (111) either cubic or flat tables; the faces most frequently uneven and dull.

Fastlandet (ɔ: the Continent) (Rink). Crystallized together with analcite, chabazite, calcite and thomsonite. The form like the preceding one.

The Umanak district.

Igdlorssuit (Steenstrup 1881). Crystals (up to 2 cm) in basalt. The form cubic with small faces of (111); the faces rather curved and uneven.

Kilertinguaq (Steenstrup 1881). Found as beautiful, regular crystals (1—10 mm) together with a few analcite crystals. Sometimes flat tables with (111) and (100) as terminal bounding; more rarely small faces of (310); other crystals are cubic with both (111) and (310) very small. The faces regularly developed but dull, the substance opaquely white. When (Ngr. p. 59) Rink says that there is a mica-like zeolite in several localities in this region, very lustrous with a glimmering fracture, which is a neutral silicate of lime with a quite secondary amount of aluminium, it is doubtful whether a. or gyrolite is meant.

Vesterfjeld (Sole Munch 1938). In the middle of a pillow lava above the basalt conglomerate crystals have been found in cavities. Pronounced columnar form (length up to 4 cm, width up to 5 mm)

(310) by far prevails over (100), in addition (001). The faces are as a rule not particularly well-developed, the colour white.

Slibestensfjeldet (GIESECKE 27-6-1811). Here mention is made of mica-like zeolite in a foliated form and in cubic crystals; the latter is at any rate a., the former possibly gyrolite.

Angnertuneq (ROSENKRANTZ 1939). In the breccia above the ravine a few crystals were found on gyrolite; pure cubic form with length up to 8 mm. The crystals particularly well-developed with shining and plane faces; the substance clearly transparent; brownish.

Niaqornat (GIESECKE 1811). Here occurrences have been found partly of cubic crystals, dull and yellowish-white on calcite, and partly a single very large individual (5 cm in diameter) on reyerite; the form quite irregular.

Qaqap Qârssua (NOE-NYGAARD 1938). Crystallized on radiating pectolite. Most crystals are small (2—3 mm), a single one larger (15 mm long). Columnar form with (100) and (001), quite small faces of (111). The interior of the crystals rather clear and transparent, the outer part on the other hand opaque, possibly owing to decomposition.

Tupersuartâ (ROSENKRANTZ 1939). In the breccia zone a. was found in a cavity in basalt on gyrolite. Only a single crystal composed of hypoparallel parts of a rather considerable size (up to 3 cm in diameter). (310) prevails over (110), besides (111) and (001). Whitish, semi-transparent.

Kugssininguaq (ROSENKRANTZ 1938). Small crystals (about 1 mm) found in elongated cavities, probably produced from bits of wood which have been dissolved, and of which there are still traces left.

Marrait (RINK). Small crystals (about 5 mm) on calcite; flat tables (111) and (100) prevailing boundary plans. The faces dull, greyish or opaquely white.

Niaqornârssuk (STEENSTRUP 1872). Crystals (about 15 mm) in cavities in basalt together with thomsonite. Occurrences partly of flat tables bounded by (100) and (111), and small faces of (310), partly of cubic crystals with small faces of (111). The faces imperfectly developed and dull.

Hareø (GIESECKE 1811). Found in cavities in basalt in two forms, partly larger, cubic crystals (about 2 cm), partly smaller (about 1 cm) crystals together with stilbite and chabazite; the form is pointed pyramide (111) with smaller faces of (100).

The Ritenbenk district.

Tuapaussat (Steenstrup 1881). Regularly developed cubic crystals (up to 8 mm) in cavities in basalt-tuff. Whitish, semi-transparent.

Sarfarssuit (Giesecke 10-7-1811). Here partly small (about 2 mm) crystals, cubic with small faces of (111), partly larger (about 15 mm) flat tables with (100) and small faces of (111); the small crystals are rather clear, greyish, the larger whitish-opaque.

Ingnangnaq (Steenstrup 1873). Crystals (up to 15 mm) in cavities in dolerite, cubic with small (111); the faces rather well-developed, the crystals whitish and dull.

Ritenbenk Coal Mine (Giesecke 1811). A single specimen without any rock attached to it, with rather large (2 cm) crystals (001), (100) and (111) nearly equally large, (310) smaller. The faces sometimes regular, shining, sometimes skeletal; semi-transparent. The same occurrence also comprises a. as a columnar aggregate.

Qutdligssat.

Brewster: Trans. Roy. Soc. Edinb. 1822.

Brewster describes tub-shaped crystals and gives a detailed description of the optical anomalies, which are found here as in nearly all other a. The material at hand consists of crystals (about 1 cm), chiefly bounded by (100) and (111) with small faces of (001). The faces well-developed and shining, the crystals clear and transparent.

Ujaragssuit (Steenstrup 1872). The crystals chiefly like those from the preceding locality. The faces of (001) are in certain cases shining at the boundary plans and very uneven in the middle; the boundary between the two areas is quite sharp and parallel with (111).

The Godhavn district.

Skandsen (Porsild 1902). A large geode (about 23 cm) mainly filled with a felt-like ptilolite; in the latter at one side a granular mass without developed crystals; the substance quite clear and transparent.

Per Dams Skib (Steenstrup 1898). Crystallized (5—10 mm) in larger cavities in basalt, without other zeolites. (001), (100) and (111). The faces shining, very curved.

Brededal (Steenstrup 1872). Small crystals (up to 3 mm) in cavities in basalt. (100), (111) and (001), nearly equally large; (310) and (113) smaller; the latter is only found in a re-entrant angle at the base. The faces of the prism zone vertically striated, shining. The faces of the pyramids well-developed, the base dull. The colour whitish.

Ivnarssuit and Karartut (GIESECKE 1807).

GMELIN: Vet.-Akad. Handl. Stockholm, 1816, p. 171.

STROMEYER: Gött. gelehrte Anzeigen, 1819, p. 1995.

GIESECKE: Trans. Roy. Soc. Edinb. 1821.

RUMPFF: Tschermak's Min. u. Petr. Mitth. N. F. 2, 1880, p. 385.

Found in very large quantities in basalt tuff. The crystals are very differently developed; the principal mass has (001), (100) and (111) almost equally developed (such a form is pictured by RUMPFF, pl. III, No. 20) to which are sometimes added small faces of (310). The faces very irregular; as a rule the crystals are composed of sub-parallel individuals, in which manner the basal faces become concave, the other faces convex. But besides this form also others are found; some are tabular with (001) and (100), with well-developed shining faces, opaque, with thomsonite, analcite and natrolite, while others are pyramidal with (111) and (100); they are also sometimes greater (about 1 cm), untransparent with stilbite or quite small (about 2 mm), forming a loose granular mass.

The specific gravity was by GMELIN determined at 2.217; analyses were undertaken by GMELIN (1) and STROMEYER (2).

	1	2
SiO_2	53.90	51.8564
CaO	25.00	25.2235
K_2O	6.13	5.2923
H_2O	15.70	16.9054
	100.73	99.2776

In the description of his travels GIESECKE calls the mineral by the name of mesotype; in his catalogues, made after his return, he gives it the name of brünnichite in honour of the professor of mineralogy BRÜNNICH at Copenhagen. GMELIN reports that WAD, from whom he had got his mineral, also gives it that name; he calls it himself ichthyophthalmite, an older name for a.

Qorôrssuaq.

SCHRAUF: Sitzb. d. k. k. Akad. d. Wiss. Wien 62, 1870, p. 699.

Crystallized in flat tables; it is characteristic that a single twin with twin plane (111) has been found, the only one described in the mineral; its size is about 3 cm.

Akiarut (GIESECKE). A. in coarse-grained form occupies the middle of a geode, the outer parts of which are filled with natrolite + thomsonite, within which is a layer of gyrolite containing a. At least in certain areas, a. is penetrated by great quantities of needles of natrolite. Peculiarly striking is the parallel growth of natrolite and mesolite in certain areas, which phenomenon shall be described under the natrolite.

Røde Elv (ɔ: red river) (Porsild 1926). Loose crystals (up to 2 cm); the faces the usual ones, but the crystals are of a very composite structure, so that they rather resemble irregularly rounded masses. Whitish, semi-transparent.

Godhavn (Olrik 1865). Crystallized (about 1 cm) together with small calcite crystals. Tabulae parallel to (001); (100) and (310) almost equally great, (111) very small; the faces uneven and curved; whitish, semi-transparent.

Kuanerssuit (Giesecke 8-9-1811). Small (2—10 mm) crystals, prismatic with (100), (001) and quite small faces of (111). Giesecke mentions "schöner vierseitiger prismatischer mit 4 Flächen zugespitzter Mesotype".

Tarajungitsoq (Giesecke 19-7-1813). Crystallized on mesolite; form as in the preceding.

Qarusuit (Steenstrup 1898). Crystallized (1—3 cm) with scolecite and tables of stilbite with (100), (111) and small faces of (310); the faces uneven and curved.

Eqalunguit (Kornerup 1880, Porsild 1915). Kornerup's material consists of crystals of the form of an acute pyramid, (100) and (111) with stilbite; the length of the crystals up to 2 cm. Porsild's material is a very coarsely columnar aggregate, without freely developed crystals. Both are purely white, semi-transparent.

The Julianehaab district.

Niaqornârssuk (Giesecke 2-9-1806).

Giesecke: Catalogue of Minerals, p. 207.

As to the occurrence very little is known; in the description of his travels Giesecke mentions ichthyophthalmite in granite [nepheline-syenite?] together with hornblende [ægirine or arfvedsonite?], calcite, felspar and beryl [apatite?]. In his catalogue a. is mentioned in fragments; in the collections of the Mineralogical Museum of Copenhagen no material is present.

Tuperssuatsiaq (Flink 1897). In a pegmatite chiefly consisting of ægirine, arfvedsonite and microcline there is a white vein, a few millimetres thick and consisting of natrolite and a. The walls consist of radiating natrolite, whereas the interior is a granular mixture of both minerals. In small cavities crystals of both (at most 1 mm in diameter); a. is bounded by (001) and (111).

East-Greenland.

Kap Brewster (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 114.

Crystals (1—15 mm) in a cavity; cubic form with (111) very small; the faces imperfectly developed, dull-brownish, semi-transparent.

Sydbræ (Bay 1891).

Bøggild: ibid.

Found in small quantities, crystallized together with thomsonite and stilbite; the form (100) and (111) with very small faces of (001) and (310). The faces curved, very uneven. Semi-transparent, greyish. From the same locality columnar a. in basalt (length of the columnae up to 4 cm).

170. Narsarsukite. $Na_2(Ti,Fe)[(O,OH,F)Si_4O_{10}]$.

The Julianehaab district.

Narssârssuk (Jessen 1894, Flink 1897).

Flink: M. o. G. 14, 1898, p. 234.

Flink: M. o. G. 24, 1901, p. 154.

Crystallized tetragonally, probably in the pyramidal hemihedrism, all known forms are shown on fig. 66. For the greater part the crystals are tabular, parallel with the base; a few smaller crystals are, however, cubic or even prismatic. Owing to the extremely strong prismatic cleavage, it is comparatively rare to find unbroken crystals. The faces of (001) are dull and uneven, the faces of the prism zone are shining but strongly striated vertically, whereas the narrow pyramid faces are plane and shining.

Very complete cleavage parallel with *m* (110); hardness a little more than 7, specific gravity 2.751. Vitreous lustre, on the cleavage

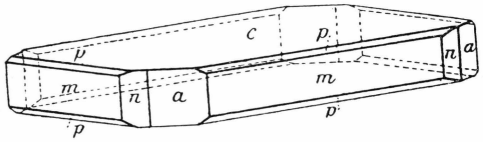


Fig. 66. Narsarsukite. Narssârssuk. (After Flink).

faces pearly lustre. The colour honey-yellow with a reddish-brown shade in the undecomposed areas, but ochreous or brownish-grey when decomposed. In rather thin sections a distinct pleochroism is visible; ε reddish-yellow, ω colourless. Birefringence positive; $\varepsilon = 1.5842$, $\omega = 1.5532$[1]) (with yellow light).

Before the blow-pipe n. is easily fusible; insoluble by acids. Analysis undertaken by Chr. Christensen: SiO_2 61.63, TiO_2 14.00, Fe_2O_3 6.30, Al_2O_3 0.28, MnO 0.47, MgO 0.24, Na_2O 16.12, F_2 0.71, H_2O 0.29 =

[1]) In the tables of Larsen and Berman these values are more correctly given as 1.609 and 1.630.

100.04 ÷ 0 (= F_2) 0.30 = 99.74. From this analysis FLINK deduces the formula $Ti_2Si_{12}O_{22}Na_6FeF$.

N. has been found in rather large quantities in several of the secondary localities at Narssârssuk. It is generally accompanied by the minerals which most frequently occur in the pegmatite veins of this locality viz. felspar and ægirine, but it is most characteristic of the mineral that it nearly always occurs together with quartz. Of the minerals mentioned the ægirine is as a rule older than n., the others younger, which also applies to the various rarer minerals; there is, however, also a younger generation of small crystals of n. After FLINK's days a quantity of material has been produced though of quite a different appearance from what was known before then. This is distinguished by n. forming a complete compact mass together with the principal minerals mentioned; but in the new material these masses are loose and fine-grained, and n. itself is as it were dissolved into small columns, though with a uniform orientation, that is, a sort of crystal-skeletons.

The mineral was first found by JESSEN in 1894, and later FLINK and others have collected a large material. In his first treatise FLINK calls it "yellow tabulae", later on he named it Narsarsukit after the place of occurrence. The name is extremely justificable, as the mineral occurs in great quantities in this locality and has not yet been found in other places, where this very easily distinguishable mineral may, however, be found any day.

171. Talc. $Mg_3[(OH)_2Si_4O_{10}]$.

This mineral occurs in a very great number of localities in Greenland, and the main mass of occurrences, where it is found in massive or fine-grained form, are more interesting from a petrographic than from a mineralogical point of view. As, however, a number of the occurrences are or have been of great economic importance to the inhabitants for the manufactoring of cooking vessels etc. a comparatively large amount of it will be recorded in the following. The mineral is frequently mentioned in the older literature, and whether it is always a case of talc is not quite sure, but very probable; this applies to such names as soapstone, potstone, in German Speckstein, Topfstein and in Danish Spæksten (lardstone), Grydesten (potstone) or Vægsten. A number of the occurrences are in Greenlandic called Uvkusigssat, which means a place where potstone is to be found.

The Thule district.

Ivssugigsoq north of Kap York (NATHORST 1883).

TÖRNEBOHM: Geol. Fören. Förh. Stockholm, 8, 1886, p. 434.

Found in a loose block on the shore. According to the Eskimos a layer of potstone is said to be found farther north, and from there they fetch material for their utensils.

The Umanak district.

Marmorilik (Noe-Nygaard 1939). In the marble are found numerous masses of talc in the form of plates, which may have a diameter of 2—3 cm in one dimension, 1 cm in the other dimension and a thickness of 1—2 mm; the structure is fine-grained, the colour snow-white. On the boundary between the talc and the marble are seen numerous very small grains of other minerals which are not easily determined.

Uvkugissat (Giesecke 3-5-1811).

Rink: Ngr. p. 41.

Here greenish talc is mentioned together with actinolite, asbestus, and pyrite in mica-schist.

Anoritôq (Rink).

Rink: Gr. I, 2, p. 215.

Found in foliated form of a greyish-green colour, sometimes in small insignificant crystals. It sometimes encloses apatite crystals.

Qarajak Fjord (Rink).

Rink: Gr. I, 1, p. 183.

Mentioned by Rink as one of the most important occurrences of the mineral in North-Greenland, where generally speaking far smaller quantities occur than in South-Greenland. The sample at hand is a finely, foliated schist with a great quantity of anthophyllite intermixed.

Sarfarfik (Rink).

Rink: Ngr. p. 41.

Found in marble in the shape of pseudomorphs after diopside in small octogonal prisms; all stages of transition occur; the colour is greyish, greenish or brownish. There are also larger continuous masses of the mineral.

Marrait (Rink).

Rink: Ngr. p. 59.

Rink: Gr. I, 2, p. 211.

The talc-like mineral mentioned by Rink as occurring together with the asbestus-like wollastonite has, on closer investigation, proved not to be this mineral, as the refraction is too small; it will be mentioned later under kaolinite.

The Godhavn district.

Fortunebay (Olrik 1860). Light-green, rather pure, finely foliated and of a very loose consistency, nearly earthy. Optical properties in entire agreement with talc; as to the occurrence of the rather considerable samples nothing is known.

The Jakobshavn district.

North of Atâ (Sylow 1883).

Sylow: M. o. G. 8, 1898, p. 28.

West of the lake of Taserssuaq, at a height of about 350 m a fairly large segregation of talc is found in the granite, the central parts of which are adopted to being manufactured; nearer the boundary plans it becomes a rather impure, greyish-green schist with highly folded layers. The samples at hand contain numerous dolomite crystals.

Kangerdluarssugssuaq (Kangerdluarssuk), the head of — (Sylow 1883).

Sylow: M. o. G. 8, 1883, p. 27.

In all essentials resembling the preceding locality.

Pâkitsoq, the head of — (Rink).

Rink: Ngr. p. 45.

Rink: Gr. I, 1, p. 183.

Sylow: M. o. G. 8, 1889, p. 27.

Mentioned by Rink as one of the most important occurrences of talc in North-Greenland, another important occurrence being Qarajaq. It forms a layer of dark greenish-grey, fine-grained or massive talc-schist wedged into gneiss; the samples at hand, however, seems to be very impure.

The Christianshaab district.

Nûk (Rink).

Rink: Ngr. p. 41.

Found in dolomite, together with tremolite, quartz, mica, diopside and augite; it is completely analogous with the North-American rensselaerite, in that it forms pseudomorphs after a pyroxene, with the parting faces of the latter parallel with (001) and (100); the optic orientation of the talc is regular with the parting faces parallel with (001) of the pyroxene and the optic axial plane parallel with (010) of the latter. Hardness 2—3. Analysis undertaken by Rink: SiO_2 63.33, MgO 31.16, FeO 3.33, relict 2.18 = 100.00. This corresponds very nearly with the composition of the talc, when the lacking determination of water is taken into consideration. The colour brownish-white, the substance very brittle.

The Egedesminde district.

Manîtsoq.

Rink: Ngr. p. 41.

Is recorded to occur as talc-schist with staurolite; on the specimens from this locality in the Mineralogical Museum of Copenhagen the staurolite is found in mica-schist.

The Sukkertoppen district.

Söndre Strömfjord (RINK).

RINK: Gr. II, App. p. 145.

From here there is a single plate, 12 cm in diameter, of a quite pure, light-greenish talc. RINK reports it to have been handed in by Greenlanders south of Strömfjord, and nothing further is known of the locality.

Kûgssuaq in Söndre Strömfjord (J. A. D. JENSEN 1884).

JENSEN: M. o. G. 8, 1889, p. 57.

Here soapstone is recorded to have been found in connection with asbestus, talc and actinolite; possibly the same locality as the preceding one.

Atangmik (NYEBOE 1915). Coarse-grained aggregate (individuals about 1 cm in size) with quite irregularly orientated individuals, together with olivine and chlorite (see these minerals). Also a few tremolite crystals occur in the talc; the colour is greyish and greenish-white.

The Godthaab district.

Kuvnerssuaq (GIESECKE 1808). By its structure and colour greatly reminding of the latter, but quite pure.

Ataneq, north of Ujaragssuit.

JENSEN: M. o. G. 8, 1889, p. 89.

A large block apparently in situ of soapstone, about 3 m in length, the surface of which has streaks scratched into it, which streaks according to the description of the Eskimos were supposed to be runes, until JENSEN proved them to be of quite chance origin.

Ujaragssuaq (Ujaragssuit).

H. EGEDE: Det gamle Grønlands Nye Perlustration etc. 1729.

H. EGEDE: Omstændelig og udførlig Relation angaaende den grønlandske Missions Begyndelse etc., 1738, p. 92.

GIESECKE: 5-8-1808.

Mentioned by EGEDE as a beautiful soapstone of different colours, green, red or white with black spots. GIESECKE partly mentions talc-schist, partly a bed of "Talkstein" oder "Topfstein" used by the Greenlanders, who however are also able to use the talc-schist. A sample collected in 1885 by J. A. D. JENSEN consists of a pure, finely foliated talc of a greenish-grey colour.

Narsatsiaq (GIESECKE 9-8-1808). Mentioned as the most considerable bed, which he had until then seen in the whole of Greenland, both as regards "Talkschiefer" and "Topfstein". The Greenlanders frequently spend weeks here during the summer, more particularly to

utilize the latter stone, whereas the former often contains actinolite and is not so fit for use.

Sidlisit, Qârusuk and Pinguarssuk (GIESECKE 28-7-1811). Mentioned as the most considerable talc-bed in Greenland after Qarajat. "Gemeiner Talk" and "Topfstein" are mentioned together with mica- and chlorite-schist, as well as various other minerals.

Amitsuarssuk (PINGEL). Greenish-grey, fine-grained with a number of groups of long, thin radiating actinolite needles.

Oriartorfik (GIESECKE 4-6-1810). Described as a considerable talc-bed on the top of a mountain, otherwise consisting of mica-schist. Both ordinary talc and talc-schist of a grey, reddish or bluish colour are found.

Narssaq (KORNERUP 1878).
KORNERUP: M. o. G. 1, 1879, p. 82.
Small layers of light, greenish-grey soapstone.

Qarajaq (GIESECKE 13-9-1808). This talc-bed, according to GIESECKE the largest in Greenland is found in mica-schist and contains actinolite and amiant.

Aunikasik at Qarajaq (FÆSTER 1944). The relation between this locality, which is near Qarajaq, and the one visited by GIESECKE is not known; but at any rate all the minerals from this locality have a peculiarity which is hardly known elsewhere in Greenland, viz. the presence of large intergrown individuals (cf. p. 187). Practically only one individual of talc is known (more than 1 dm in dimension) grown together with and through magnesite, which also occurs in one large individual (p. 136). The colour light greenish-grey.

Íkátoq (FÆSTER 1939). Columnar and foliated (sizes of individuals up to 1 cm) together with chlorite; the colour whitish.

The Frederikshaab district.

Smallesund (ɔ: narrow sound) (STEENSTRUP 1877).
STEENSTRUP: Rigsdagstidende 1877—78; App. B, p. 4.
Is recorded to be found as very thick layers of potstone with large crystals and therefore less fit for use.

Kingigtoq (GIESECKE 10-6-1809). Found in several varieties, of which particular attention must be paid to one which is light-brownish, large-leaved, and fibrous.

Sermersôq (GIESECKE 14-8-1809).
RINK: Gr. II, p. 144.
Found in the form of talc-schist and potstone as layers in mica-

schist. Mentioned by RINK as the most southern locality in which talc fit for use can be found, and both GIESECKE and RINK record the fetching of talc in this locality by the inhabitants of the Julianehaab district.

The Julianehaab district.

Renø (ɔ: reindeer island).

IVAR BAARDSØN: Grønlands historiske Mindesmærker, 3, p. 56.

WORMSKJOLD: Det skandinaviske Litteraturselskabs Skrifter 1814, p. 338.

The occurrence, the situation of which is unknown, is characteristic as being the oldest mentioned finding place of minerals in Greenland. The report is from the 14. century and the part played by it in the discussions as to the situation of the old eastern settlement is very great. IVAR BAARDSØN describes RENØ as a large island, situated Einarsfjord, where the best potstones of Greenland are found, so good in fact that jugs and pots can be made of them and so large a jug as to be able to hold 10—12 barrels may be made out of one piece. Outside Einarsfjord which is generally considered identical with Igaliko Fjord, there are now no large layers of potstone, no more than in the remaining part of the Julianehaab district. GIESECKE, it is true, mentions large beds at Akia (see below), but the Greenlanders were obliged to undertake long journeys in a northerly direction in order to fetch the necessary material. The name of the island makes one think of one of the islands, Tugtutôq outside Narssaq, and Tugtutuârssuk outside Unartoq Fjord, but none of these can be said to be situated outside Igaliko Fjord, even though they are not so very far removed from it, and on none of them there is in recent times any potstone. It is, however, possible that the occurrence has been exhausted, more particularly if it has consisted of a large quantity of loose boulders, as seems appear from the description. This mention of potstone has naturally often been used as a proof that the eastern settlement cannot have been situated in the Julianehaab district.

Akia (GIESECKE 13-8-1806).

RINK: Gr. II, App. p. 145.

From here are recorded large layers of talc-schist; a sample at hand shows a fine-grained, rather pure rock of a grey colour.

Sigssardlugtoq at the Igaliko Fjord (HOLM 1880).

HOLM: M. o. G. 6, 1883, p. 110.

Immediately south of the outlet of the river into the fjord there is an occurrence of potstone, which is very much decomposed and which possibly already has been used.

Ũnartoq Qingua (Holm 1880).

Holm: M. o. G. 6, 1883, p. 110.

A couple of hundred steps to the south of the most easterly ruin a boulder of potstone is found.

East Greenland.

Uvdlorssiutit (Eberlin 1884).

Graah: Undersøgelsesrejse til Østkysten af Grønland, 1832, p. 86.

Eberlin: M. o. G. 9, 1889, p. 255.

Mentioned by Eberlin as the only locality in the whole of southern Greenland, where potstone fit for use is found. In the gneiss and granite there were intercalations as large as houses of a kind of rock, hard in the interior but in the outer areas and along fissures altered into an impure and hard potstone. Eberlin is of the opinion that the stone fit for use occurs in the same manner, but that the quantity cannot be very considerable; it is being recorded in 1828[1]) that every summer boats came from the east coast to Aluk in order i. a. to barter potstone from the west coast i. e. probably as far as from the Frederikshaab district. In contrast with this Cranz[2]) tells that eastlanders from (perhaps far) north of Puisortoq sold potstone to the West-Greenlanders.

Akitseq in Køge Bugt (Knutsen 1885).

Knutsen: M. o. G. 9, 1889, p. 244.

Holm: M. o. G. 10, 1888, p. 51.

Mentioned one of the places from which the inhabitants of Angmagssalik are more particularly supplied with potstone; according to Knutsen it is softer than that found at Angmagssalik. The name Akitseq is a special East-Greenland name for potstone[3]).

Inigssalik (Knutsen 1885).

Holm: M. o. G. 10, 1888, p. 220.

Mentioned as the second of the localities from which the inhabitants of Angmagssalik fetch potstone. The samples brought home consist of a rather impure, greyish, massive talc.

Kobberpynt (ɔ: copper point), Gaasefjord, and Renodde. (ɔ: reindeer point) in Scoresby Sund (Bay 1892).

Bay: M. o. G. 19, 1896, p. 159.

Here veins of potstone in picrite are mentioned of a very varying and casual direction. A sample from Kobberpynt shows a brownish-white, fine-grained talc, very pure with the exception of small scattered biotite-leaves.

[1]) Nachrichten aus der Brüdergemeinde, p. 41.

[2]) Nachrichten von Grönland 1, 1761, p. 349.

[3]) Rink: M. o. G. 10, 1888, p. 220.

172. Paragonite. $NaAl_2[(OH,F)_2AlSi_8O_{10}]$.

As this mineral can only be distinguished from muscovite by means of a chemical analysis, it will be natural seeing that p. is by far the rarest of the two minerals, only to record it where analyses are found, as from Ivigtut. From this locality there is, however, also an analysis of muscovite, so it is impossible to say with certainty, how much of the mica found there belongs to one or the other of the two minerals.

The Frederikshaab district.

Ivigtut.

Rand: Proc. Akad. Nat. Sci. Phil. 1868, p. 142. — Amer. Journ. Sci. 46, 1868, p. 400.

Hagemann: Amer. Journ. Sci. 47, 1869, p. 133.

Johnstrup: 12. Skand. Naturforskaremötets Förh. Stockholm, 1880, p. 240.

Occurs in a very fine-grained form as thin veins in the white cryolite, particularly often between the latter and the siderite crystals. The directions of the veins mentioned are irregular. The colour is yellowish-brown, sometimes dark-green. Rand records the specific gravity at 2.05, but as it is otherwise recorded at 2.78—2.90, very loose material must have been used. Analyses undertaken by Rand (1) and Hagemann (2):

	1	2
SiO_2	36.49	41.41
Al_2O_3	24.09	39.01
Fe_2O_3	7.54	
Na_2O	16.03	10.27
K_2O	—	1.05
H_2O	3.42	3.49
F	0.75	tr.
	88.32	95.23

Rand's analysis has been undertaken on 0.679 gm material and must, it seems, contain a good deal of cryolite. Hagemann's analysis does not differ very much from the usual composition of the mineral, so there can hardly be any doubt that it is really p. Rand and Hagemann regarded it as a new mineral, which they called by the name of ivigtite.

In by far the greater quantity there occurs along the southern edge of the cryolite mass a yellowish-green mass of a very fine consistency, so that only in a few cases it is possible to observe the mica-like structure. Johnstrup found that this mineral contains more SiO_2 and less Na_2O than is recorded above, so that he parallellizes it with the gilbertite from the Saxon tin occurrences; this mineral which is a kind of muscovite, only contains an infinitesimal quantity of Na_2O. In the said fine-grained mass a larger quantity of minerals are imbedded,

as f. i. quartz, violet fluorite, black cryolite, siderite, pyrite, zircon and others. Further, there are numerous small mica-leaves (1—2 mm) which sometimes have a rather irregularly hexagonal form and are probably the same mineral as the ground-mass, all possible transitions in size being found; the colour is light-yellowish-green. In polarized light the leaves prove to be built up each of a single individual with an axial angle of about 63°.

Besides these smaller mica-leaves there are also a number of irregularly bounded masses (2—5 cm); it is not easy to see, whether they are to be looked upon as individual crystals or as aggregates with nearly the same orientation of the individual leaves, in which case they must be pseudomorphs. The colour is greenish on the cleavage planes, sometimes with a strong pearly lustre. The individual mica-leaves are of an almost microscopical size with the axial angle nearly like the one recorded above; they contain a great quantity of small areas of other minerals, more particularly fluorite, quartz and perhaps cryolite.

173. Muscovite. $KAl_2[(OH,F)_2AlSi_3O_{10}]$.

This mineral occurs almost everywhere in the older formations, but in this context there is only reason to mention a comparatively small number of more striking occurrences.

The Umanak district.

Niaqornat, east of — (Sole Munck 1939). Here a loose block was found, consisting of a highly folded rock with interchanging layers (up to 1 cm thick) of white quartzite and a very strong green chrome-mica; the latter is found in very fine-leaved masses, and only once in a while individuals of a few mm in length are met with. In the mica a number of quite small chromite grains are found, and besides grains of a dark mineral with adamantine lustre, which in transmitted light has a strong brown colour and is generally penetrated by numerous twin-lamellae. The mineral probably cannot be determined in details.

The Ritenbenk or Godhavn district.

Disko (the missionary Ginge).

Schumacher: Nat. Selsk. Skrivter, 4, 2. Hefte, 1798, p. 228.

Schumacher: Versuch eines Verzeichnisses der in den Dänish-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 38.

Leonhard: Handbuch der topographischen Mineralogie, 1, 1805, p. 340.

Found as fillings in fissures in a light quartzitic rock, which can also occur as fragments in the mica; the latter consists of an irregular accumulation of fragments of spheres or spherical shells, and the single

individuals as a rule do not attain more than 3 mm. The colour is nearly black with the exception of the cleavage planes, which have a very strong pearly lustre. According to a determination made by USSING the axial angle (2 E) is 69°, and USSING also states on the label that the mica should be twins.

There are very strong points of resemblance between the mica from this occurrence and the one from Arsuk Fjord which will be mentioned later on. But the surrounding rock shows a somewhat different microscopical structure, and in particular the manner in which the mica crystals are placed is very different. In the case of the old specimens present in the Mineralogical Museum of Copenhagen, no occurrence is recorded; it is in the literature that Disko is recorded as the finding place, and though these old second- and third-hand records are perhaps not particularly certain, the material itself seems to contradict the identity of the two occurrences.

The Christianshaab district.

Saituaraq (SYLOW 1883). Crystallized in cavities in gneiss together with quartz. The crystals (about 1 cm) are hexagonal prisms with imperfectly developed, curved faces.

The Egedesminde district.

Sakordleq (RINK). A larger table (diameter 16, thickness 1 cm) unaccompanied by other minerals; on the label it is recorded to be taken from a coarse-grained albite vein. Folded and with a distinct parting in one direction which forms 60° with the optic axial plane. The colour brown.

Manîtsoq. A single table (8 cm) without other minerals. Striated in the different areas in three directions, the one direction being parallel with the optic axial plane. The mica only constitutes one individual, the colour faintly brown and greenish.

Tasiussaq. A single table (12 cm) without other minerals; striated and with parting in one direction, forming 60° with the optic axial plane. The colour brown. Generally speaking with a complete resemblance to the mineral from Sakordleq.

The Holsteinsborg district.

Súngoq (The BERNBURG expeditions 1903—04). From these expeditions a great quantity of samples were brought back, partly very large ones, of a diameter up to 0.5 m and weighing up to 5 kg. The locality of occurrence possibly not quite certain. The mica is rather impure and the leaves undulating, and at any rate nothing is known

as to their possible practical use. The colour is slightly brown. The optic axial angle is rather small, seeing that nearly all values up to 20° for 2 E can be found, and thus it is possible that it is a phlogopite.

The Godthaab district.

Qasigianguit (Giesecke 17-9-1808).

Descloizeaux: Manuel de Minéralogie, 1, 1862, p. 487.

Found in large crystals (up to 16 cm) bounded by (001) and (010) and (111); the marginal faces are imperfectly developed, but may nevertheless be measured in the goniometer. Sometimes there are in the interior regular brown striae parallel with the marginal faces; besides the interior is as a rule filled with dark dendritical bodies. No striation on the cleavage planes, but a faint parting in the three usual directions, which form 30° with the marginal faces. The colour brownish-green, the optic angle (according to Descloizeaux) 71°.

In Descloizeaux there is in the same place a mention of a mica from Nulluk in Greenland with an axial angle of 70°36′. It can hardly be referred to any definite locality.

Qarajat (Giesecke 13-9-1808). In most respects bearing such a great resemblance to the preceding that the localities must in all probability have been exchanged for each other. 2 E has by Ussing been determined at 72°.

Fiskenæsset.

Leonhard: Handb. d. Oryktognosie, 1821, p. 464 (Kikertarsoeitsiak).

Is recorded to have been found in tables interchanging with thin quartz layers; in the Mineralogical Museum of Copenhagen there is only a single table (7 cm) without regular bounding, faintly brownish in colour.

The Frederikshaab district.

Island in Arsuk Fjord (Tayler).

Rink: Gr. II, App. p. 145.

Found in a very peculiar shape, viz. as small (about 5 mm) regularly semi-spherical crystals on parallel fissures in a fine-grained, hornstone-like rock. The colour of the mica is dark with a strong pearly lustre on the cleavage planes. As to the relation to the mica from Disko, which resembles it very much, see what has been said below about this locality.

Ivigtut.

Steenstrup: M. o. G. 34, 1910, p. 143.

As proved by Steenstrup fine-grained mica masses were frequently found in the cryolite, being placed in exactly the same manner

as the topaz; it is also possible to find the two minerals bounding upon each other. The mineral has been analyzed by CHRISTENSEN (in STEENSTRUP): SiO_2 47.9, Al_2O_3 (Fe_2O_3) 37.0, K (presumably K_2O) 9.9, MgO 1.6, loss on ignition 3.3 = 99.7. The analysis agrees very well with the usual one of muscovite, and there is hardly any doubt that it is this mineral we are dealing with.

Judging by the analyses there are thus occurrences both natron- and kali-mica at Ivigtut, and as in the imperfect material it is impossible with certainty to distinguish the two minerals from each other by means of their physical properties, many cases will naturally occur, where an attempt at distinguishing mica from this occurrence must be abandoned.

In the Mineralogical Museum of Copenhagen there is a single specimen collected by NORMANN in 1869, and consisting of a whitish fine-grained rock of nearly pure albite, in which there are large (up to 10 cm broad and 1 cm thick) tables of muscovite. The specimen can hardly originate from the actual cryolite massif, but be presumed to belong to the Precambrian formations lying round the latter.

The Julianehaab district.

Nunarssuit (MOTZFELD 1853). A single crystal about 2 cm in diameter and found in a pegmatite vein, consisting of amazonite and quartz together with biotite crystals. The faces quite indefinable, the colour brown, the axial angle (2 E) $57^1/_2°$.

Akuliaruseq (Akuliarusiarsuk) (GIESECKE 30-7-1809).
STROMEYER: Gött. gelehrt. Anzeigen, 1819, p. 1993.
LEONHARD: Handbuch d. Oryktognosie, 1821, p. 644.
PHILLIPS' Mineralogy, 1823, p. 113.
BREITHAUPT: Vollst. Charakteristik des Mineralsystems, 1823, p. 182.
MOHS: Grundr. d. Min. 2, 1824, p. 650.
PFAFF: Schweigger's Journ. 45, 1825, p. 103.
GLOCKER: Handb. d. Mineralogie, 1829, p. 830.
TAMNAU: Pogg. Ann. 43, 1838, p. 149.
PINGEL: Om den af Porphyrgange gennembrudte røde Sandsten i det sydlige Grønland, 1843, p. 18.
KENNGOTT: Sitzungsber. d. k. k. Akad. d. Wiss. Wien, 9, 1852, p. 602.
BLUM: Pseudomorphosen, 2. Nachtr. 1852, p. 131.
v. HAUER[1]): Jahrb. d. k. k. Geol. Reichsanst. Wien, 5, 1884, p. 76.

[1]) The material described by HAUER is recorded to originate from Nunasarnaussaq, situated at Kangerdluarsuk; as however no corresponding formation is known from this locality, STEENSTRUP and USSING are of the opinion that the specimen must be a loose block, or that the locality given must be wrong.

Descloizeaux: Ann. d. Mines, 5. Sér. 14, 1858, p. 417.
Breithaupt: Berg- u. hüttenmänn. Zeit. 1866, reprint, p. 36.
Steenstrup: Rigsdagstidende 1877—78, App. B, p. 11.
Ussing: M. o. G. 14, 1898, p. 121.

The formations belonging here have formerly been very famous, being regarded as an independent mineral called gieseckite. They have, however, been proved to consist of pseudomorphs of mica or nepheline, and there are all possible stages of transition between the unaltered greenish and the entirely metamorphosed greyish-green nepheline; the latter case is by far the most common one. The crystals are of the usual nepheline from partly with shining faces and sharp edges. In the half altered crystals the mica-leaves are seen to lie in the periphery and along fissures; those entirely altered consist of a very fine aggregate, (the diameter of the leaves up to 0.2 mm) with the leaves sometimes placed parallel with the base of the nepheline, sometimes lying irregularly. There are, however, also other alteration products intermixed with them. The specific gravity is determined at 2.832 (Mohs), 2.793 (Kenngott), 2.725 (Stromeyer) and 2.78 (Hauer). Analyses have been undertaken by Stromeyer (1), Kenngott (2) and Hauer (3 and 4).

	1	2	3	4
SiO_2	46.0798	48	46.40	45.36
Al_2O_3	33.8280	32.5	26.60	27.27
FeO	—	—	6.30	
Fe_2O_3	3.3587	4	—	
Mn_2O_3	1.1556	—	—	
MnO.....	—	—	tr.	
MgO.....	1.2031	1.5	8.35	7.39
K_2O	6.2007	6.5	4.84	
H_2O	4.8860	5.5	6.76	6.78
	96.7119	98.0	99.25	

The results of the analyses agree fairly well with the usual composition of muscovite.

The name gieseckite was given to the mineral by Sowerby (in Stromeyer)[1]). At the beginning opinions varied very much as to its properties; the crystal form was first determined by Leonhard as obliquely rhombic columnae with an angle of 59°, whereas Philips and Mohs determined it as hexagonal. Breithaupt supposed the formations to be altered mica-crystals, whereas Glocker classed them with nepheline; he supposed that the minerals were identical, whereas Blum proved the gieseckite to be pseudomorphs after nepheline. The first

[1]) Dana (Mineralogy 1892, p. 621) records that Allan (Ann. of Phil. 2, 1813) has created the name. In this place there is however nothing about the mineral.

optical investigation was undertaken by DESCLOIZEAUX who found that the gieseckite was a "rubber-like substance" (i. e. was amorphous). Only with USSING's examinations the structure of the mineral was entirely cleared; the above remarks are in the main an extract of these.

East-Greenland.

Arferssuaq in Sermilik (RÜTTEL 1902). Crystallized in pegmatite; the single individuals are up to 1 dm in diameter and 6 cm thick, but everywhere interrupted by the interjacent quartz. Hexagonal prisms with undefinable faces. It is peculiar that the muscovite is sometimes interrupted by biotite, which is accurately orientated in the same manner; it is a sharp, as a rule irregular boundary between both micas; the orientation of the percussion figures is the same. The colour of the muscovite is faintly brownish, that of the biotite black.

Ikáteq (EJNAR MIKKELSEN 1945). Cleavage fragments of a light-brownish colour which is recorded to be common in the region.

Aluit (RÜTTEL 1902). Loose mica-leaves (up to 6 cm) without surrounding rock. Orientation of the optic axes, percussion figures, and striation as usual. The colour in some places whitish-brown with a very strong pearly lustre, in others dark-brown.

Greenland without definite locality.

From FÆSTER the Mineralogical Museum of Copenhagen in 1939 received samples of a mica-schist with an otherwise quite normal structure consisting of quartz and mica, but the latter is very vividly green in colour, like the one mentioned above from Niaqornat. The structure is the usual one with thin layers of mica interchanging with quartz; the individual mica-leaves are rather large. It seems probable that it is here a question of chrome-mica.

174. Phlogopite. $KMg_3[(F,OH)_2AlSi_3O_{10}]$.

The Egedesminde district.

Eqalugssuit (KORNERUP 1879).

KORNERUP: M. o. G. 2, 1881, p. 155.

Small crystals (generally 1—3 mm) together with spinel, chondrodite and olivine in dolomite; the bounding of the crystals is irregular, but the prevailing form is that of hexagonal tables. The colour is brownish, the axial angle very small, at most about 17°. In 1939 the Mineralogical Museum of Copenhagen received from FÆSTER material, of which far by far the prevailing part consists of phlogopite with smaller quantities

of dolomite and a few small spinels. The size of the phlogopite individuals here attains about 2 cm.

Nagssuqtôq, northern side of — about 22 km from the mouth (PJETURSSON 1897).

PJETURSSON: M. o. G. 14, 1898, p. 291.

Small crystals, together with olivine, spinel and graphite in dolomite.

The Holsteinsborg district.

Ungôriarfik (KORNERUP 1879). In all essentials like the preceding locality.

Súngoq (the BERNBURG expedition 1903—04). See under muscovite, p. 329.

The Godthaab district.

Qarajat (GIESECKE 13-9-1808).

TSCHERMAK: Sitzungsber. d. k. k. Akad. d. Wiss. Wien, 100, 1891, p. 29. — Zts. Kryst. 21, 1893, p. 429.

The geological conditions of this region are, it seems, rather intricate. GIESECKE mentions a formation of mica-schist intersected by a large talc layer, in which black and greenish mica is found together with various other minerals. In the specimens originating from GIESECKE's collections, which are present in the Mineralogical Museum of Copenhagen, mica only occurs intergrown with massive areas of fibrous anthophyllite and also penetrated by the latter so as to produce asterism. TSCHERMAK describes large tables of chlorite, in which the phlogopite is found, partly in the outer areas and partly as streaks and spots in the interior.

In more recent times (1944) FÆSTER presented the museum with a material originating from a place near Qarajat, called Aunikasik; the combination of minerals from here is described on p. 187. Whether this locality is identical with those formerly visited it is not possible to say, but there are certain points of resemblance in the contents of minerals, thus particularly in the occurrence of phlogopite and chlorite. In the material at hand the phlogopite occurs in rather large tables grown together with enstatite, olivine and fibrous anthophyllite.

The phlogopite from Qarajat is dark, transparent of a red-brown colour; the optic axial angle is very small (according to Tschermak up to 20°). According to this author it belongs to the group anomite.

175. Biotite. $K(Mg,Fe,Mn)_3[(OH,F)_2AlSi_3O_{10}]$.

Biotite is found nearly everywhere in the older formations of Greenland. In the following a limited selection of the more considerable occurrences will be given.

The Umanak district.

Ikerasak on Ũmánatsiaq (Giesecke 29-4-1811). Found in the outer areas of a pegmatite vein, in the shape of rather regular, hexagonal crystals (3 cm) together with green apatite. The marginal faces irregular, curved and dull. The colour black.

The Godhavn district.

Upernavik Næs (Giesecke 12-6-1812). Hexagonal tables (up to 4 cm) in pegmatite. The terminal faces indistinct, the colour black.

Fortunebay (Steenstrup 1872). Irregularly formed, black tables (up to 7 cm) in pegmatite.

The Egedesminde district.

Sungaussaq (Sylow 1883). A single larger sample (diameter 20 cm, thickness 4 cm) rather impure and folded, with smaller quantities of felspar and quartz enclosed in them.

Eqalugssuit (Fæster 1939). Coarse-grained aggregate with individuals up to 6 cm in size, together with smaller quantities of quartz. The colour in most cases black, in thin leaves brownish; at the outer edge of the sample mica becomes nearly colourless.

Nagssuqtôq (Porsild 1915). A larger cleavage fragment (diameter 15 cm) of a greenish-black colour.

The Holsteinsborg district.

Súngoq (the Bernburg expeditions 1903—04). Locality of the occurrence rather uncertain (cf. muscovite, p. 328). The samples at hand are very large (3—4 dm). The colour is purely black, and only very thin leaves are transparent.

Holsteinsborg, an island 15 km north of — (Søltoft 1862). Thin tables (diameter up to 8 cm) in coarse-grained quartz penetrating this mineral in all directions; no marginal faces; the colour greenish-black.

The Godthaab district.

Narssatsiaq (Giesecke 10-8-1808). Crystallized together with hornblende and actinolite in tables (up to 8 cm). The marginal faces everywhere very indistinct and uneven. The colour dark-brown.

Qârusulik (Giesecke 22-9-1808).

Kobell: Kastner's Arch. f. d. ges. Naturlehre, 12, p. 29.

Descloizeaux: Manuel de Minéralogie, 1, 1862, pp. 487 and 493.

Mica-schist with numerous large tourmaline crystals enclosed. A few mica-leaves, up to 1 dm in diameter: the faces rather regular, faintly curved. The colour dark greyish-green. The optic axial angle according

to Descloizeaux 1—2°. Analysis undertaken by Kobell: SiO_2 41.00, Al_2O_3 16.88, Fe_2O_3 4.50, FeO 5.05, MgO 18.86, K_2O 8.76, H_2O 4.30 = 99.35.

Qarajap Ilua (Steenstrup 1888). Coarse-grained masses together with felspar and quartz; the diameter of the individual tables about 1 dm, the thickness up to 3 cm. The colour dark greenish-brown.

Fiskenæsset (Steenstrup).

Ussing: Öfvers. K. Vet.-Akad. Förh. Stockholm, 1889, No. 1, p. 17. — Zts. f. Kryst. 15, 1889, p. 605.

Found in the main variety of the sapphirine-bearing rock, which in addition contains gedrite, hornblende and sometimes kornerupine, iolite and plagioclase; colour light-yellow; specific gravity 2.807. The optic axial angle is very small; the mica is an anomite.

From Rink originates a single hexagonal plate (about 6 cm) of b.; as locality is recorded Fiskenæsset, but this is probably not certain.

The Julianehaab district.

Nunarssuit (Motzfeld 1853). Crystallized in pegmatite together with amazonite and quartz; also a few crystals of muscovite. The form very irregular, sometimes fairly distinctly hexagonal prisms (up to 3 cm). The colour dark-brownish.

Narssârssuk (Flink 1897).

Flink: M. o. G. 14, 1898, p. 232.

Flink: M. o. G. 24, 1901, p. 109.

Has been found as individual tables without being associated with any other mineral, but probably originating from the syenite-pegmatite. The size up to about 5 cm. Bounded by the faces (010) and (110). When fresh the biotite is black, sometimes with a greenish tinge; it is nearly optically uniaxial; the axial plane is parallel with (010). The greater part of the mica is decomposed to chlorite and untransparent, of an ash-grey or reddish-brown colour.

Kanajormiut. The mica from here is not only the most characteristic in Greenland, but as it seems something quite unique. As to the occurrence very little is known; of the four samples in the possession of the Mineralogical Museum of Copenhagen the first one is very old (more than a hundred years) while the second one has been given to Steenstrup in Ivigtut. The two last pieces are both recorded to originate from the small island of Kanajormiut, which lies at the mouth of Sermersôq; they are presents from Mrs. Meldorf and the engineer K. Fæster. As to the manner of occurrence nothing is known up to the present and still less of the manner of formation. The mica resembles a kind of concretions of a nearly spherical form (fig. 67), with a diameter of 3—5 cm. The surface of the spheres is highly shining,

on all sides formed by the cleavage plane, so that it may also be said that the faces of the base extend continuously round the whole sphere. Two of the spheres are broken right across, and it is then seen that with the regularly concentrically built shell of mica with a thickness of about 1 cm, there is an irregularly formed fragment of a fine-grained

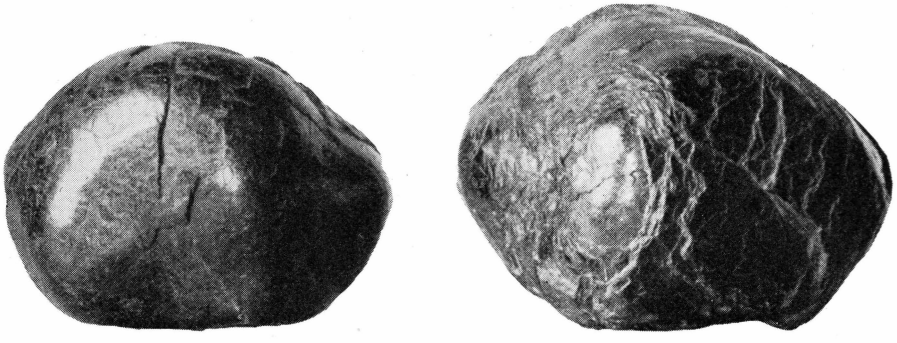


Fig. 67. Biotite. Kanajormiut. 1:1.

granitic rock. The colour is black, and the mica is only transparent in the very thinnest leaves with a brown colour; the streak is dark-brown.

East-Greenland.

Ikáteq (Einar Mikkelsen 1945). Here are collected samples (up to 5 cm) of b. without other minerals; the colour black, in very thin leaves brown.

Kap Hedlund (Noe-Nygaard 1932). On the peninsula at K. H. up to 15 cm large crystals in quartzite were found, together with small garnet fragments up to 1 cm thick, distinctly hexagonal in shape with very irregular faces. The colour black, in thin plates brown.

176. Polylithionite. $KLi_2Al[(F,OH)_2Si_4O_{10}]$.

This mineral is generally regarded as a variety of zinnwaldite. However, it seems to me that the composition of the mineral from the two Greenland occurrences, with their strong mutual resemblance, differ as much from all other occurrences that it will be natural to follow Lorenzen, who regards it as an independent mineral.

The Julianehaab district.

Narssârssuk (Lytzen's Collection 1893).

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 208.

Flink: M. o. G. 14, 1898, p. 232.

Flink: M. o. G. 24, 1901, p. 110.

Found crystallized together with pegmatite, more particularly together with felspar and elpidite, which both in the main are formed

at an earlier period than p.; furthermore, together with later formed cordylite, synchysite, ancylite and apatite. The crystals are up to 5 mm in diameter and 1 mm thick; if they have been exposed to decomposition, they are rounded at the boundary plans, otherwise they may be

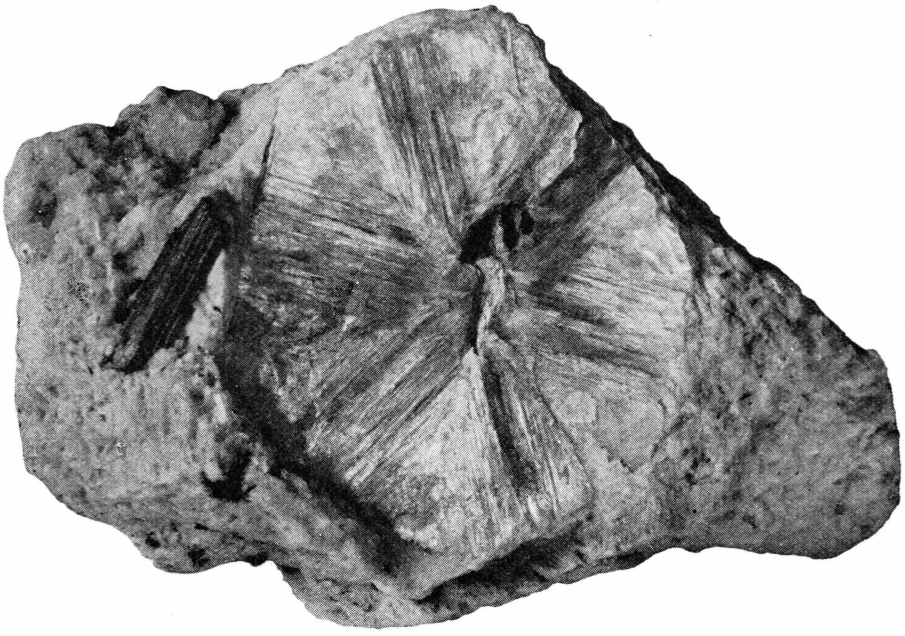


Fig. 68. Polylithionite Kangerdluarsuk. 1:1.

well-developed. The known forms of p. are (001), (010), (201), (017), ($\bar{1}$.1.11), ($\bar{1}$14), ($\bar{1}$11) and ($\bar{2}$21) referred to the elements of biotite. The form is most frequently like hexagonal tables; if (010) is lacking also as rhombic tables. Often twins in agreement with the ordinary mica-law, also frequently repeated, thus producing high crystals with a horizontal striation on the prism faces.

The colour yellowish in the fairly thick crystals; in front the acute bisectrix forms an angle of 7° with the *c*-axis; 2 E is about 60°; specific gravity 2.701. The cleavage not quite as strong as in other micas. Analysis undertaken by FLINK: SiO_2 58.68, Al_2O_3 10.24, Fe_2O_3 4.02, MnO 0.31, LiO 8.24, K_2O 11.05, Na_2O 1.61, F 8.16 = 102.31 ÷ 3.44 = 98.87. The composition differs from the zinnwaldite by the large contents of SiO_2 and Li_2O and an essentially smaller amount of Al_2O_3, which is partly replaced by Fe_2O_3, whereas FeO is entirely lacking. Any sure formula it is difficult to establish. The composition rather corresponds with $KLi_2AlF_2Si_4O_{10}$. In his first treatise FLINK called the mineral lepidolite, in his second zinnwaldite.

The mineral has not been found outside this and the following localities.

The region of Kangerdluarssuk (STEENSTRUP 1876).

LORENZEN: M. o. G. 2, 1881, p. 70. — Min. Mag. 5, 1882, p. 49.

LORENZEN: M. o. G. 7, 1893, pp. 12 and 43. — Öfvers. k. Vet.-Akad. Handl. Stockholm, 1884, No. 2. — Medd. Stockholms Högskola, 1884, No. 21. — Zts. Kryst. 9, 1881, p. 251.

Found everywhere in the pegmatite dykes in the nepheline-syenite, and particularly in the granular albite, which almost everywhere accompanies these veins. The mineral forms large (up to 9 cm) tables together with steenstrupine, ægirine and analcite; particular attention

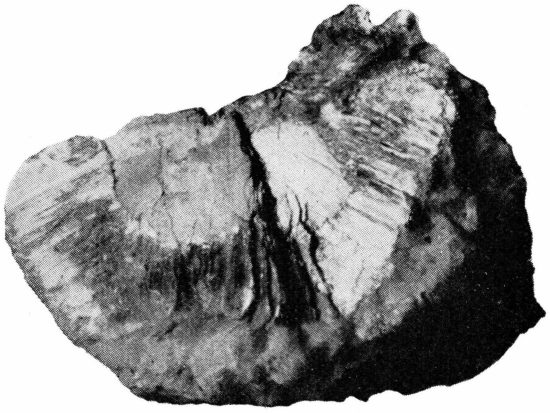


Fig. 69. Polylithionite. Kangerdluarssuk. 1:1.

must, however, be paid to the frequent occurrence together with epistolite (fig. 69), which most frequently is found in the middle of the plates with irregular boundaries towards p.; the two minerals have parallel cleavage directions. Apart from that the tables of p. are distinguished by a star-shaped structure, seeing that they consist of six sectors, each with a fine, radiating striation dependent upon the folding of the leaves (fig. 68). The colour is faintly greenish; hardness 2.5; specific gravity 2.81. The optical axial plane is at right angles with the said folds, 2 E is 67°19′. The acute bisectrix forms an angle of 5—8° with the *c*-axis. Analysis undertaken by LORENZEN: SiO_2 59.25, Al_2O_3 12.57, FeO 0.93, K_2O 5.37, Na_2O 7.63, Li_2O 9.04, F 7.32 = 102.11 ÷ O 3.08 = 99.03. The composition agrees very well with that from the preceding locality to which the reader is referred; only there is an essentially greater quantity of Na_2O.

Owing to the large amount of Li contained in it LORENZEN named the mineral polylithionite; at that time it was the mineral with the greatest amount of lithium, but later on it has been surpassed by the cryolithionite from Ivigtut.

(Lepidolite).

L. is mentioned by GIESECKE (12-7-1806) as occurring at Julianehaab; it is, however, not found in any of the collections brought home, so that it has not been possible to establish, whether the determination is correct, but it does not seem likely. FLINK (M. o. G. 14, 1898, p. 232) records it as occurring at Narssârssuk, the Julianehaab district, but it has later on proved to be polylithionite (cf. p. 337).

177. Spodiophyllite. $(Al,Fe)_2(Mg,Fe,Mn)_3(Na,K)_4Si_8O_{24}$.

The Julianehaab district.

Narssârssuk (JESSEN 1894, FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 232.

FLINK: M. o. G. 24, 1901, p. 85.

Found exclusively as crystals which have the form of a hexagonal prism with a base; sometimes they seem to consist of thin triangular plates which frequently form twins in such a manner that the one is turned 60° in relation to the other; it is consequently possible that the crystals are trigonal. The base is most frequently plane and shining; sometimes it is striated parallel with the edges towards the prism faces. The latter are always strongly horizontally striated and uneven; frequently they are quite indistinct, the outlines of the crystals being rounded. Very often one end of the crystals is thicker than the other, though distinct pyramid faces have not been developed. Frequently all the leaves are curved so that one end is concave, the other convex, and this is particularly marked in the rather large crystals (up to 1.5 cm high and 3 cm wide) which have appeared during later years.

Very strong cleavage along the base, in which respect the mineral very much resembles mica or chlorite. In a fresh stage the cleavage is not so strong as in somewhat more altered material; the individual cleavage leaves are not pliable or elastic. Hardness a little more than 3; specific gravity 2.633. The colour most frequently ash-grey, sometimes with a brownish shade, at the base pearl-grey, most frequently with a strong pearly lustre. In sections the mineral is almost colourless with a faint yellowish shade and some different absorption ($\omega > \varepsilon$). In sections parallel with the base zones are frequently seen parallel with the edge, constituted of the more coloured areas. The mineral is optically uniaxial with a faint negative birefringence.

Analysis undertaken by FLINK: SiO_2 53.61, Al_2O_3 4.27, Fe_2O_3 11.24, FeO 4.13, MnO 0.64, MgO 10.16, Na_2O 8.55, K_2O 7.80 = 100.40. These values agree fairly well with a formula: $(Al, Fe)_2(Mg, Fe, Mn)_3(Na, K)_4 Si_8O_{24}$. The mineral does not show any closer relationship with any other, and the systematic position is quite uncertain. Owing to a certain outward similarity, it is generally classed with the minerals of the mica group.

When heated before the blow-pipe s. melts with some difficulty to clear colourless glass; it is not dissolved by acids.

S. is found in rather small quantities in the pegmatite veins, where it belongs to the first-formed minerals; it is accompanied by ægirine, zircon, ancylite, rhodochrosite and albite.

The mineral which in FLINK's first treatise was called chlorite, was later on named s. on account of the ash-grey colour and the foliated structure; the mineral has not as yet been found elsewhere.

178. Tæniolite. $KLiMg_2[FeSi_4O_{10}]$.

The Julianehaab district.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 234.

FLINK: M. o. G. 24, 1901, p. 115.

Crystallized in the monoclinic system with the same elements as biotite and with the faces (001), (010), (023) and ($\bar{1}11$). The crystals are flattened along the base, but also—and this is very unusual in a mica mineral—ruler-shaped, elongated in the direction of the *a*-axis; at the ends they are nearly always rounded. The faces of the base are generally shining and plane, the other horizontally striated. A single twin with a twin plane (100) has been found.

Complete cleavage along (001); the leaves not very elastic. Hardness presumably as in other micas 2.5; specific gravity 2.86. The mineral is completely transparent, colourless or faintly bluish. The acute bisectrix forms in front an angle of 5° with the *c*-axis; the optic axial plane is parallel with (010), the axial angle, 2 E is 50°. The analysis was undertaken by MAUZELIUS (on 0.097 gm of material): SiO_2 52.2, Al_2O_3 2.7, FeO 0.6, MgO 19.1, K_2O 11.5, Na_2O 1.8, Li_2O 3.8, relict 8.3 = 100.0. Any approximately reliable formula cannot be given; it depends i. a. very much upon whether the remainder is H_2O or F or something else; the composition at any rate differs strongly from all micas, to which t. otherwise in most respects bears a strong resemblance, by its nearly complete lack of Al_2O_3.

Before the blow-pipe t. easily melts into a colourless glass, full of blebs; it is only slowly dissolved by acids.

T. has been found in cavities in the pegmatite in quite small crystals up to 5 mm in length, 1 mm in width and of a thickness which is only a fraction of a millimeter. The crystals may be rather numerous, but as may be imagined, the total mass is very slight. The mineral is for the greater part found on ægirine and felspar crystals, which are also frequently grown into the felspar. Of other accompanying minerals special mention should be made of narsarsukite and graphite.

In his first treatise FLINK named the mineral "glimmeragtiga listor" (mica-like strings); in his second treatise it was given the name of t. after the Greek names for ribbon and stone. The mineral, or at any rate one which resembles it in a very high degree, has later been found as quite small crystals in Russian Lappland.

179. Seladonite. Almost of the same composition as glauconite.

A green substance, the s., is here as in other places common in the basalt formation, as a rule in the shape of thin layers between the basalt and the zeolites segregated in the cavities. There is no reason to record the single occurrences, and it will be sufficient to mention the place where the s. apparently occurs in the largest continuous masses.

The Godhavn district.

Igpik (GIESECKE 1807, O. R. B. HANSEN 1937). The two samples are very different from each other; the one collected by GIESECKE is of a pure, rather compact and continuous green mass, which under the microscope proves to consist of a skeleton or network of the green substance, whereas the main mass between these elements consists of granular zeolites. The recent sample is a more impure and loose mass of a not quite so vividly green colour; it proves to consist of breccia of very small basalt grains, and on their surface the green substance is found, whereas the interstices are partly filled with zeolite.

180. Glauconite. $K_{2-3}(Mg,\overset{II}{Fe},Ca)_{1-3}(\overset{III}{Fe},Al)_{3-6}[(OH)_8Al_{2-3}Si_{13-14}O_{40}]$.

This mineral has, in later years, been found in several localities in sedimentary rocks. In West-Greenland it is found in small quantities in tuff layers from the Danian formation; in East Greenland it makes part of various greensands from the Jurassic formation in the region round Scoresby Sund. There is no reason to emphazise any special locality.

181. Chlorite. Different hydrous Silicates with *Al*, *Mg*, *a. o.*

The Umanak district.

Qaersuarssuk (ARN. HEIM 1909). In a locality 800 m above sea-level, just above the glacier, chlorite-schist was found superimposed upon the gneiss. The colour of the rock is dark bluish-green, the schistocity is little pronounced. The size of the chlorite-leaves most frequently 1—2 mm, more rarely up to 1 cm. Strong pleochroism: dark-green, yellowish, optically uniaxial, negative. Besides chlorite the rock contains a great quantity of quartz.

The Godhavn district.

Engelskmandens Havn (ɔ: the harbour of the Englishman) (O. R. B. HANSEN 1937). Large leaves (up to 5 cm) in pegmatite, the

leaves greatly curved. The colour dark-green with a strong pearly lustre. Pleochroism: dark-green, light-brownish. Uniaxial, negative.

Tarajungitsoq (Giesecke 1-8-1812). Layers of chlorite-schist in hornblende-schist; when the rock disintegrates, a rather pure, earthy chlorite is formed. Optical conditions like the preceding.

At the neighbouring occurrence of Qarssuanguit Qaqait a quite similar, earthy c. has been collected.

The Christianshaab district.

Sârdlat (Giesecke 5-9-1812). Found in quartz as pseudomorphs (up to 3 cm) after a pyroxene mineral with combination (100), (010) and (111); the faces uneven, curved. The chlorite dark-green, very fine-grained; as far as can be seen, the optical conditions are as in the case of the preceding ones.

Ikamiut and Puaviarsuk (Rink). Small thin leaves together with oligoclase, tourmaline and ilmenite. The colour green. Optic axes and signs not accurately definable.

The Sukkertoppen district.

Atangmik (Nyeboe 1915). Crystallized in olivine and talc. At the line dividing these minerals there are numerous small (about 1 mm) crystals, whereas there are none in the olivine farther away from this line. In the talc, at a greater distance from the olivine there is, on the other hand, a few larger (up to 5 mm) chlorite crystals. The chlorite is black, but even in rather thick plates greenish, with the usual pleochroism. The form regular, hexagonal. Optically almost uniaxial, positive.

The Godthaab district.

Ikarissat (Fæster 1927). A single cleavage fragment (about 6 cm) together with a smaller quantity of actinolite. Thin leaves are colourless, thicker green or black. Pleochroism the usual one: Optically biaxial, positive.

Qarajat.

Tschermak: Sitzungsber. d. k. k. Akad. d. Wiss. Wien, 100, 1891, p. 29. — Zts. f. Kryst. 21, 1893, p. 429.

Is reported to be found in large hexagonal tables consisting of clinochlore of a dark emerald-green colour; the optic axial angle (2 E) is 85°. Twin formations according to the usual mica-law. Grown together with phlogopite (cf. p. 333).

In material handed in by Fæster in 1944 there is also a chlorite with exactly the same properties, but the conditions of occurrence are somewhat different (cf. p. 333). Particularly characteristic is the occur-

rence as small areas, which all belong to the same large individual, and which are found in enstatite and olivine, also in very large individuals. The occurrence is recorded to be Aunikasik at Qarajat.

Ikátoq (GIESECKE 1809, STEENSTRUP 1888, FÆSTER 1939). The samples collected at various periods are rather different in kind and possibly not from quite the same locality. From GIESECKE originate partly a very fine-grained chlorite-schist, and partly a very fine-grained greyish-green rock, consisting of garnet and chlorite; on the walls of a fissure in the latter are found crystals (up to 3 mm) of a regularly hexagonal form. From STEENSTRUP originate rather large, irregularly shaped leaves, together with garnet crystals. FÆSTER's material, on the other hand, is mixed with talc, sometimes in such a manner that leaves of chlorite (up to 4 cm) are found scattered in the talc. Colour and pleochroism as usual; the mineral is biaxially positive with an infinitesimal axial angle.

The Julianehaab district.

Narssârssuk (FLINK: M. o. G. 14, 1898, p. 232).

The material found in this place by FLINK and named chlorite has, on subsequent investigations undertaken by FLINK, proved to be spodiophyllite.

Kangerdluarssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, pp. 241—42.

A chlorite found in greenish-blue tables, 1 cm in size, has by FLINK been referred to tabergite, a variety of penninite; the mineral has not yet been investigated in detail.

Lichtenau (GIESECKE).

JANOVSKY: Ber. d. D. chem. Gesell. zu Berlin, 1873, p. 1230.

VRBA: Sitzb. d. k. k. Akad. d. Wiss. Wien, 69, 1874, p. 91.

Clinochlore in compact, lamellary aggregates; specific gravity 2.702, colour dark-green. The finding place unknown, but the sample was received in LICHTENAU. Analysis undertaken by JANOVSKY: SiO_2 30.32, FeO 7.71, CaO 1.28, MgO 29.88, Al_2O_3 17.90, H_2O 12.28, P_2O_5 0.11, F tr., SO_3 tr. = 99.48.

East-Greenland.

Ikáteq (EJNAR MIKKELSEN 1945). Slightly southeast of I. thin plates, up to 3 cm in diameter, have been found in an asbestus-like anthophyllite. The colour dark-greenish; positive, with a very small axial angle.

182. Serpentine. $(MgFe)_3H_4Si_2O_9$.

The Umanak district.

Ũmánatsiaq (GIESECKE 1-8-1811). A loose block consisting of pure s. of the usual consistency; the colour dark-greyish-green.

The Egedesminde district.

Eqalugssuit (KORNERUP 1879). Small grains (1—5 mm) as pseudomorphs after olivine, with the rounded form of this mineral; some grains only partly altered. The colour greyish-green.

Between Eqalugssuit and Nagssugtôq (FÆSTER 1938). Chiefly like the preceding.

Nagssugtôq. Northern side of — about 20 km from the mouth (PJETURSSON 1897). Chiefly like the preceding.

The Holsteinsborg district.

Ungôriarfik (KORNERUP 1879). Chiefly like the preceding.

The Godthaab district.

Qarajap Qingua (STEENSTRUP 1888). Microcrystalline, dark-green s. together with small leaves of biotite.

Without definite locality (RINK). From "Fiskenæsset District" a loose block of a rather impure serpentine of a dark greyish-green colour is at hand.

The Frederikshaab district.

Iluilârssuk (RINK). Rather large samples (up to 2 dm) of an impure, very shining and fibrous serpentine. The fibres in the main parallel, but still so entangled that the consistency is not like that of asbestus. The colour varies from black to light-yellowish-green.

Kingigtoq (GIESECKE 10-6-1810). Judging by the quantity of the collected material, it seems to be a very considerable occurrence, all the more as there are a number of different varieties. The structure may be the one which is typical of the mineral, without any definite longitudinal extent of the elements, but there may also be a pronounced tendency for the fibres to orientate themselves in one direction, and there are typical examples of chrysotile. Most samples are of a rather impure appearance, with dark greyish or greenish colours, but there are also examples of lighter greenish or yellowish colours, and in a few cases the substance proves fairly translucent as a transition to precious serpentine.

Kangârssuk (STEENSTRUP). From this occurrence which is situated very near the preceding and may perhaps be regarded as being identical with it, some samples are at hand, chiefly of the same kind as those mentioned above.

The Julianehaab district.

Asardlut in Ũnartoq (LAUBE).

VRBA: Sitzb. d. k. k. Akad. d. Wiss. Wien, 69, 1874, p. 30.

JESSEN: M. o. G. 16, 1896, p. 129.

Found at the boundary of a huge diorite-porphyry dyke, connected with it by transitions, the serpentine having been produced by the alteration. The colour is yellowish or greenish-grey; hardness 2.5; specific gravity 2.825. The serpentine is rather impure, mixed with apatite, magnetite and oligoclase. The locality seems to be rather strongly utilized. An analysis has been undertaken by VÖLKER: SiO_2 40.91, Al_2O_3 11.41, Fe_2O_3 5.37, FeO 6.04, MgO 25.92, CaO 2.35, Na_2O 2.62, K_2O 0.37, H_2O 4.21 = 99.20. After deducing 6 % of magnetite and 30 % of oligoclase a composition remains, almost corresponding with $Mg_3H_2Si_2O_8$, which only by the smaller amount of water contained distinguishes itself from the ordinary serpentine formula.

183. Kaolin group. Mixture of different hydrous *Al*-Silicates.

This mineral must be supposed to be omnipresent in Greenland, even though, as far as is known, it has not been mentioned a single time and is not found in pure beds. But in this context there may perhaps be occasion to mention a few occurrences of soft, homogeneous substances, occurring in the basalt formation and formerly called lithomarge (Steinmark etc.), even though they have probably nothing to do with kaolinite. It is hardly possible to determine the minerals belonging here without a chemical analysis, as the external properties are rather alike, and the surest and most varying property, the refraction, has not been determined in the case of most of the analysed minerals. A number of the "minerals" in question are presumably nothing but colloidal mixtures, with varying composition and properties.

The Umanak district.

Marrait (RINK).

RINK: Ngr. p. 59.

RINK: Gr. I, 2, p. 214.

Found together with asbestus-like wollastonite; according to RINK a massive form, yellowish in colour and a greenish columnar form is to be found, but I have not seen the latter form myself and it is possibly something else. The yellow form is very soft and soap-like of consistency; one would be apt to call it saponite, if this were a single mineral. Refraction about 1.51; birefringent.

The Ritenbenk district.

Ritenbenk Coal Mine (GIESECKE 1811). Filling of cavities together with small quantities of the radiating zeolites. The colour brown. The consistency like that of the preceding mineral occurrence. Refraction about 1.52; birefringent.

The Godhavn district.

Sarkanguaq (GIESECKE Sept. 1807). Recorded by the name of "Bol" this mineral is found as a thin layer between basalt and amygdaloid and also in cavities together with analcite.

Lyngmarken (ɔ: heather field) and the Godhavn peninsula (RINK).

RINK: Ngr. p. 57.

Occurs in rather large quantities in cavities in basalt, either alone or together with crystals of chabazite. The colour is pink and light reddish-brown in the two localities. An analysis by RINK has yielded Al_2O_3 and CaO and traces of MgO. RINK writes that the material is soft as tallow, and that it bursts into fragments when brought in touch with water; this I have also seen, whereas the consistency in my opinion is rather hard. The refraction is unusually small (about 1.48). The substance is isotropic.

Augpalartoq (GIESECKE September 1807). GIESECKE mentions red lithomarge, the specimens present in the Mineralogical Museum of Copenhagen have a strong yellowish-green colour. The refraction is 1.61, the substance is birefringent.

184. Hisingerite. Hydrous Ferrisilicate.

The Ritenbenk and Godhavn districts.

Uivfaq, Asuk, Mellemfjord and other of the iron-occurrences on Disko.

NAUCKHOFF: Bihang Vet.-Akad. Handl. Stockholm, 1, 1873, No. 5. — Ber. Deutsch. chem. Gesell. 6, 1873, p. 1463. — Miner. Mitth. Wien, 1874, p. 109. — Lotus, Prag, 23, 1873, p. 223.

STEENSTRUP: Vid. Medd. Nat. Foren. Kjøbenhavn, 1875, p. 284.

TÖRNEBOHM: Bihang Vet.-Akad. Handl. Stockholm, 5, 1878, No. 10.

LAWR. SMITH: Annal. Chim. Phys. 16, 1879.

NICOLAU: M. o. G. 24, 1901, p. 215.

H. is here found in particularly large quantities, and is particularly well known from the iron-occurrence Uivfaq, but it is also found in the other known iron-occurrences and in other localities, particularly at the finding place of pyrrhotite, Igdlukúnguaq. It is often irregularly shaped, but sometimes it has a fairly regular spherical form, and most frequently it is found in close association with the iron or the pyrrhotite, sometimes as sharply bounded grains within this mineral, which seems to exclude the possibility of their having been produced by the alteration of the latter.

In its physical properties h. agrees entirely with the mineral from other localities; the specific gravity is determined at 2.919 (NAUCKHOFF) and 2.908 (NICOLAU). Analyses undertaken by NAUCKHOFF (1), LAWRENCE SMITH (2) and NICOLAU (3).

	1	2	3
SiO_2	31.70	30.04	32.07
Fe_2O_3	51.49	57.12	49.63
FeO	3.81	—	4.05
MgO	—	—	1.51
H_2O	13.56	10.89	14.02
S	—	—	0.11
	100.56	98.05	101.39

These analyses agree very well with others of the same mineral; only the amount of iron is rather large in the case of the Greenland mineral.

A peculiarity of this mineral is its quick alteration when exposed to the air; when first detached from the rock it is light olive-green and highly iridescent, but in the course of a few minutes it becomes black. TÖRNEBOHM called the light-coloured variety by the name of chlorophæite, but the existing analyses of this mineral do not agree with the above. Whether the change of colour is accompanied by any chemical alteration is not known, as the light-coloured variety has not been analysed. But also the black variety is altered; in the course of a year the fractures are changed from vitreous and shining to pitchy and dull. This change is accompanied by an oxidation of the iron, NAUCKHOFF having proved that when the mineral was left in exsiccator for three weeks, FeO sank from 3.81 to 1.55, and the amount of water decreased from 14.02 to 11.87.

RINK (Gr. II. App. p. 151) mentions chlorophæite as occurring in North-Greenland. It is hardly probable that the mineral meant is the one described above, as it has only become known after the discovery of the genuine iron at Uivfaq; but nothing is known as to what is the meaning of the statement and the manner of undertaking the determination.

185. Naujakasite. $Na_{1-2}(Al,\overset{III}{Fe},\overset{II}{Fe})_{2-3}[(O,OH)_2Si_4O_{10}]$ (?).

The Julianehaab district.

Naujakasik (FLINK 1897).

BØGGILD: M. o. G. 92, No. 9, 1933, p. 7.

Crystallizes in the monoclinic system; in habits the crystals very much resemble the minerals of the mica-group by having the form of tables, which are frequently rather distinctly hexagonal in outline, and

by the perfect cleavage in the plane of the tables. The cleavage-planes are white in colour, with a very strong pearly lustre, which is sometimes rather metallic; cross-fractures are dark-coloured and uneven. Hardness: 2—3; specific gravity of the purest substance 2.616.

From an optical point of view the mineral differs very much from all mica-like minerals, and thus becomes very easily distinguishable; the one optic axis is always normal on the cleavage plane, and the axial angle seems to be very large, so that the second must lie nearly at the level of the leaves and is very difficult to catch sight of. The sign rather seems to be negative. The refraction coefficient β, the only one which it is fairly easy to determine is 1.57. Before the blow-pipe n. melts easily; it is dissolved by acid with gelatinization. Analysis undertaken by CHR. DETLEFSEN: SiO_2 50.95, Al_2O_3 20.63, Fe_2O_3 2.76, FeO 5.25, Na_2O 14.51, K_2O 0.80, CaO 0.55, MnO 0.57, MgO 0.10, H_2O (100°) 1.02, H_2O (ign.) 2.60 = 99.74. This analysis most nearly agrees with the formula H_2O, $3(Na_2,Fe)O$, $2Al_2O_3$, SiO_2. Röntgenphotographic investigations have been undertaken by GOSSNER and KRAUSS by means of which the following lengths of axes were found: $a = 15.06$, $b = 7.98$, $c = 19.5$ Å; β could not be determined.

The entire material originates from a single loose block weighing about 350 gm. The specimen rather resembles a rock owing to its regular, everywhere homogeneous structure. More than half of it consists of n. the diameter of which is generally 1—3 mm; the greater part of the remainder is riebeckite (possibly arfvedsonite), which is partly found in black masses between the crystals of n., and partly forms very fine needles in the latter. When selecting the material for analysis it was impossible to separate these constituents entirely from each other; pulverized material was divided by heavy liquids into a number of fractions, the heaviest of which for the greater part contained riebeckite, the lighter chiefly impure areas of n. possibly with other, not accurately definable minerals. The middle fractions chiefly contained the pure and clear n., and were used for the analysis. Nothing whatsoever can be concluded as to the locality from which the specimen originated.

186. Okenite. $Ca_3[Si_6O_{15}]\,6\,H_2O$.

The Ritenbenk district.

Qutdligssat (Major PETERSEN).

KOBELL: KASTNER's Archiv, 14, 1828, p. 335.

Forms a mass of fibrous or microcrystalline structure; the colour is white, or faintly yellowish or bluish. Specific gravity 2.28. Analysis undertaken by KOBELL: SiO_2 55.64, $(Al, Fe)_2O_3$ 0.53, CaO 26.59, H_2O 17.00 = 99.76. This occurrence is the first from which the mineral was

described, but strange to say, the Mineralogical Museum of Copenhagen does not possess the mineral from this locality, whereas there are very large quantities from the following localities.

The Godhavn district.

Blæsedal and Skarvefjeld.

Bøggild: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1923, p. 8.

From these two neighbouring localities numerous specimens of o. have been collected, partly without connection with other minerals, partly together with chabazite or apophyllite. Most specimens are of the very hard and compact form, which is characteristic of the mineral, but there are also some which hang rather loosely together. Also at the neighbouring locality Puilasoq similar specimens have been collected.

Tarajungitsoq and Qarusuit.

Bøggild: ibid. p. 9.

Also in these two localities, which are very close to one another, the mineral has been found, as it seems in very great quantities. As accompanying minerals are found in one locality stilbite, in another apophyllite.

Evqitsoq (formerly Erkrotok).

Bøggild: ibid.

Found in a geode together with heulandite, formed at an earlier period. In a cavity in the middle freely projecting crystals, ruler-shaped and very small (the length a few millimetres, the width 0.1 mm, and the thickness up to 0.008 mm). By means of these crystals and others from the Faroes it has, however, been possible to determine the crystal form of the mineral, which has proved to be triclinic, either single crystals or twins, according to two different laws; as to these see the treatise quoted.

Greenland without definite locality.

Lemberg: Zts. d. D. geol. Gesell. Berlin, 29, 1877, p. 476.

Here an analysis is found of an o. from Greenland, however, without any detailed description of the mineral: SiO_2 55.12, Al_2O_3 0.62, CaO 27.41, H_2O 16.88 = 100.03.

An analysis undertaken by Hauer (Jb. d. k. k. Geol. Reichsanst. Wien, 5, 1854, p. 190) on o. from Iceland has by mistake been referred to Disko in the later editions of Danas Mineralogy.

187. Gyrolite. $Ca_4[(OH)_2(Si_6O_{15})]\,3\,H_2O$.

The Umanak district.

Igdlorssuit (Steenstrup).

Bøggild: M. o. G. 34, 1908, p. 102.

Thin fillings of fissures or coatings of walls in cavities in basalt; enclosed smaller areas of a substance of the nature of lithomarge and in the middle large cubical apophyllite crystals are found.

Ujaragtôrssuaq (HEIM and RAVN 1909). Separated in cavities in basalt together with lithomarge.

Ikorfat (SOLE MUNCK 1938). A rather considerable occurrence; on the walls of a large cavity a layer of dark-brown fibrous calcite (8 mm thick) has first been separated; then follows a series of very thin layers, viz. first an amorphous transparent substance, then an opaque layer and then the g., first as a fine-fibred mass, then the main mass in the form of a layer of about 8 mm of the usual foliated consistency. In several localities the free edges of the crystals are found turning towards the cavity; the crystals, however, are very imperfectly developed, while other areas are filled with large calcite individuals of a light-brownish colour.

Angnertuneq (ROSENKRANTZ 1939). Farthest out on the walls of a cavity star-shaped masses of thomsonite are found, and on this mineral the g. which shows very imperfect faces; on g. a few apophyllite crystals are found.

Niaqornat.

CORNU: Tschermak's Min. u. petr. Mitt. 25, 6. Hefte, 1907.

CORNU and HIMMELBAUER: Sitzb. d. k. Akad. d. Wiss. Wien, Mat.-natw. Klasse, 116, Abt. 1, 1907.

By far the greater part of what has formerly been described from N., under the name of gyrolite, CORNU and HIMMELBAUER refer to a new mineral reyerite to be described in the following. The authors, however, also describe g. in the form of greatly decomposed, small (a couple of millimetres) leaves, which under a magnifying glass may be seen to be hexagonal. Refraction (ω) 1.540—1.548. In the Mineralogical Museum of Copenhagen I have not seen g. from this locality.

Tuperssuartait (ROSENKRANTZ 1939). On the wall of a cavity first small groups of thomsonite have been deposited, and then a continuous layer of g. about 3 mm thick. Towards the middle very incomplete crystals are found, but the greater part of the cavity is filled with a single larger apophyllite crystal.

Niaqornârssuk (STEENSTRUP).

BØGGILD: M. o. G. 34, 1908, p. 103.

Great resemblance to that of the preceding locality; first thomsonite, then a thin layer of g. and in the middle a great quantity of apophyllite crystals.

Nûssaq (Rink).

Bøggild: ibid.

The occurrence probably a breccia with irregular cavities, in which first thomsonite and then g. have been segregated. Besides there is some granular quartz, as to the age of which nothing can be said for certain.

Nûk. On the shore a number of rolled small fragments, which presumably cannot be said to be a homogeneous material. The combination is generally thomsonite and then g.

The Ritenbenk district.

Sarfarssuk. A thin (2—4 mm) layer of g. on which a few larger apophyllite crystals are to be found.

Ingnangnaq (Steenstrup).

Bøggild: l. c., p. 104.

From this locality two samples originate; the one, as far as can be seen, consists of a crust of g. without other minerals; the other has first small groups of thomsonite, then a thin layer of g. and finally apophyllite crystals.

Nûngerut (Ravn 1909). On a wall of a cavity a thin layer of g. and on it a quantity of analcite crystals.

The Ritenbenk district without specified locality (Rink).

Bøggild: l. c.

A geode, the wall of which is first covered by a layer of lithomarge; then thomsonite, then a layer of a fine-grained undefinable substance; then a layer of g.; and at last very small calcite crystals.

The Godhavn district.

Ivnarssuit.

Bøggild: l. c.

In this locality a great number of specimens have been collected at various periods, though alike in all essentials; on a foundation of natrolite there is a layer of gyrolite, and at last apophyllite crystals.

Qarartut (Giesecke).

Haidinger: Edinb. Journ. Sci. VII, p. 19.

Gregg and Lettsom: Manual of the Mineralogy of Great Britain and Ireland, 1858, p. 95.

Cornu: Tschermak's Min. u. petr. Mitt. 25, 6. Heft, 1907.

Cornu und Himmelbauer: Sitzb. d. k. Akad. d. Wiss. Wien. Mat.-natw. Klasse 116, Abt. 1, 1907.

Bøggild: M. o. G. 34, 1910, p. 105.

This occurrence is very close to the preceding one, and the specimens from the two occurrences are also essentially alike; the material is uncommonly pure and clear. Determinations of the specific gravity have been undertaken by CORNU and HIMMELBAUER (2.422) and also by the author (2.418). C. and H. have arrived at the result that g. is younger than the apophyllite, which is not the case with the material at my disposal.

Qôrorssuaq (GIESECKE).

CORNU and HIMMELBAUER: l. c.

C. and H. describe three different specimens from this locality. No. 1 has first g. + analcite, essentially simultaneous, and at last apophyllite. The specific gravity of g. has been determined at 2.388, the index of refraction ω at 1.545. No. 2 has first a thin layer consisting of g. + analcite + natrolite; then okenite and at last apophyllite, which may enclose small globules of g. No. 3 shows the following succession: gyrolite, natrolite, apophyllite, gyrolite. The Mineralogical Museum of Copenhagen possesses no specimens from this locality.

Akiarut (GIESECKE).

CURRIE: Min. Mag. 14, 1904, p. 95.

Here Akiarut is recorded as a supposed occurrence of g., according to GIESECKE's description in his diary p. 255 "massive apophyllite" and "pearl-white, radiated mesole". The passage in question refers to the Umanak district, and the only place in GIESECKE's diary where A. is mentioned is p. 287, and here the above mineral is not found. A sample collected by GIESECKE and now present at the Mineralogical Museum of Copenhagen has first groups of natrolite then gyrolite and in the middle apophyllite, rather irregularly distributed.

Tarajungitsoq (GIESECKE 19-7-1813).

CURRIE: l. c.

The only sample in existence shows an irregular mixture of scolecite with smaller quantities of g. and apophyllite; as to the relative ages of these minerals it is impossible to say anything, excepting that the scolecite must be the oldest mineral, as it penetrates the other two.

Qarusuit (RINK).

BØGGILD: l. c.

G. from this occurrence is possibly the most beautiful and best-developed of all; g. is found directly on the walls of the geodes, and only once there is a group of thomsonite or a mass of an opal-like substance which, under the microscope proves to be of an extremely finely grained structure; it is presumably indefinable. G. has marginal faces, among which it has been possible to determine $(10\bar{1}1)$; owing to the strongly curved faces the measurements are, it seems, rather inaccurate,

but the angle between this face and the base does not at any rate essentially differ from the corresponding one in the reyerite from Niaqornat.

188. Reyerite. The composition very similar to that of the gyrolite.

The Umanak district.

Niaqornat (GIESECKE 30-5-1811).

HAIDINGER: Edinb. Journ. Sci. 7, 1827, p. 19.

LEVY: Description d'une collection de minéraux formée par M. HENRI HEULAND et appartenant à M. CH. HAMPDEN TURNER, 1828, pp. 272 and 274.

GREG and LETTSOM: Manual of the Min. of Gr. Britain and Ireland, 1858, p. 117.

HEDDLE: The Mineralogy of Scotland, 1901, p. 79.

CURRIE: Min. Mag. 14, 1905, p. 95.

CORNU: TSCHERMAK's Min. petr. Mitt. 25, 6. Heft, 1907.

BØGGILD: M. o. G. 34, 1908, p. 93.

Owing to the close relationship between r. and gyrolite the following description in the main aims at emphasizing the comparison between the two minerals.

Both minerals are rhombohedral and crystallize in hexagonal tables; of marginal faces two rhombohedrons have been found in r. $(10\bar{1}1)$ and $(10\bar{1}2)$, the latter very narrow, whereas in g. only the former has been found. The faces of both minerals are so imperfectly developed that no accurate comparison can be made between the length of the axes, but they do not seem to be essentially different. On r. it is extremely easy to produce triangular etching and percussion figures, the orientation of which shows that the crystal is rhombohedral tetartohedral; on g. it is impossible, or at any rate extremely difficult to produce the figures.

Both minerals have a strong cleavage parallel with the base, but in r. it is distinctly stronger, and also the pearly lustre on the base is more marked. The cleavage leaves of r. are hardly to be bent and break very easily, whereas in g. they are rather pliant. The hardness in the case of both minerals is 3—4; the specific gravity is determined at 2.499—2.578 (CORNU) to 2.578 for pure and 2.463 for somewhat decomposed material (BØGGILD). The specific gravity of g. is an average of 13 records viz. 2.385 (2.342—2.420).

Both minerals are optically uniaxial (or faintly biaxial), negative. The value of ω is in r. determined at 1.564 (CORNU) and 1.5645 (BØGGILD); in g. it is as an average of 11 records, 1.544 (1.540—1.548); ε is in r. determined at 1.5590 (BØGGILD), in g. at 1.536 (LARSEN and BERMAN).

R. has been analysed by CORNU (incomplete analysis): SiO_2 53.31, Al_2O_3 3.72, CaO 32.22, H_2O 6.73 = 95.98, and by CHRISTENSEN (in BØGGILD): SiO_2 54.83, Al_2O_3 4.58, CaO 31.15, Na_2O 1.74, H_2O 8.14 = 100.44. As the 8 analyses of g. existing show consonant values of SiO_2, CaO and Na_2O but differing in the case of Al_2O_3 (0—1.48) and H_2O (12.58—15.05), it is hardly possible to establish any certain formula for any of the minerals; for g. is generally the formula given: 2 CaO, $3SiO_2$, $3H_2O$, whereas r. more nearly corresponds with 2CaO, $3SiO_2$, $1^1/_2H_2O$.

As far as is known all the existing material originates from GIESECKE, presumably the only explorer who has visited the locality. The rock is recorded to be a breccia with fragments very different in size; among them there is also an amygdaloid, in the cavity of which r. is segregated; there is an ample material of the mineral, and the cavities seem to have been rather considerable in size. The succession of minerals is the one which is usual for the gyrolite, first mesolite in a layer 1 cm thick, then the r. in a 1—5 mm thick layer, and at last apophyllite of which there is one large crystal. The crystals are arranged in radiating groups, but in details with a very irregular orientation. They may attain a diameter of up to 2 cm. They are sometimes clear and transparent of consistency, sometimes white, filled with microscopical enclosures.

As mentioned above GIESECKE discovered the mineral in 1811, and he gives a very adequate description of it: "Der letztere geht oft in krummblätterige über, ist schiefrig, hat einen starken Perlenmutter, oft beinahe metallischen (Silber-) Glanz. Seine Krystallisation scheint die sechsseitige Tafel zu sein". Also HAIDINGER and LEVY describe this mineral. After the name gyrolite had been given to it in 1851, it was referred here from Niaqornat by GREG and LETTSOM, HEDDLE and CURRIE. In 1907 the author gave a detailed description of the Greenland gyrolite, still classing the mineral from Niaqornat with it. At the same time CORNU's work was published, and here he established this mineral as a new one, reyerite, named after Professor REYER in Vienna. From the above comparison it will probably have appeared with sufficient distinctness that there are such pronounced points of difference between r. on one, and all the gyrolites on the other side that it will be natural to distinguish them from each other.

189. Nepheline. *Na[AlSiO$_4$]*.

N. occurs in various localities in southern Greenland, as a constituent of more recent eruptives, particularly from the region of Kangerdluarssuk. It was however on the Kitsigsut Øer that the existence of the mineral was first proved, and at a far earlier period it had been realized that the gieseckite was a pseudomorph of muscovite after nepheline.

The Frederikshaab district.

Frederikshaabs Isblink and Kangârssuk (HOLST 1880).
TÖRNEBOHM: Geol. Fören. Förh. Stockholm, 6, 1883, p. 703.
Found as microscopical grains in loose blocks of nephelinite.

Grönnedal (HOLST 1880).
TÖRNEBOHM: ibid. p. 693.
CALLISEN: M. o. G. 131, No. 8, 1943.
Found as the main constituent in the nepheline-syenite area Grönnedal (ɔ: green valley)—Ika, partly in a fresh state, partly more or less altered to pseudomorphs of muscovite (gieseckite); also in pegmatite veins such pseudomorphs are found, but only in small quantities and the veins contain no rare minerals.

The Julianehaab district.

The region of Kangerdluarssuk (STEENSTRUP 1876).
STEENSTRUP: M. o. G. 2, 1881, p. 35.
LORENZEN: ibid. p. 61. Min. Mag., a Journal of Min. Soc. 5, 1882, p. 49.
USSING: M. o. G. 14, 1898, p. 109.
The main constituent of the various nepheline-syenites in this area, as well as in the numerous pegmatite veins. It is found, partly as irregularly formed grains, partly as crystals (up to 2 cm) bounded by (0001) and $(10\bar{1}0)$, sometimes with small faces of $(10\bar{1}1)$. The colour may be whitish, greyish or greenish; frequently a pronounced greasy lustre (elæolite) is found; greenish colours are due to the intermixture of foreign minerals, more particularly ægirine, a rarer reddish-brown colour is due to a partial alteration. Sometimes the elæolite shows a similar colour phenomenon which makes itself more pronouncedly felt in the sodalite viz. it is red-violet on fresh fractures which colour fades after a short exposure to the light. Analyses have been undertaken by LORENZEN (1 on a crystal with a specific gravity of 2.60, 2 on an irregularly shaped individual of sp. g. 2.63):

	1	2
SiO_2	43.39	41.87
Al_2O_3	32.28	33.94
Fe_2O_3	0.92	0.70
CaO	0.70	0.47
K_2O	5.62	6.68
Na_2O	16.52	15.03
Cl	tr.	tr.
Loss at ign...	—	0.94
	99.43	99.63

As proved by Ussing n. undergoes various metamorphoses; the minerals produced in this manner are:

1. Cancrinite, which is very little distributed, will be mentioned in the following.

2. Sodalite. The transformation takes place under two forms, seeing that s. is either found in segment-shaped areas along its margin or as irregularly shaped lobate areas in the interior; an intergrowth of this kind is, for that matter, not always easy to distinguish from an original graphic-granitic formation.

3. Analcite. This transformation is the most frequent and as a rule complete; a. begins on the outside and forms a steadily broadening marginal zone round n.

4. Hydronephelite. By means of this and the following transformation the so-called "Spreustein" is formed; the one consisting of h. is the most common and will be mentioned under this mineral.

5. Natrolite; Spreustein of n. is rather rare and will be mentioned in details under this mineral.

6. Muscovite. By this transformation the so-called gieseckite is produced, which has been mentioned in detail on p. 331.

The region east of Igaliko.

Ussing: M. o. G. 38, 1912, p. 229.

In the "Igaliko batholite" described by Ussing, there is a large area of nepheline-syenite; hardly any pegmatite veins have been found in it, but the greater part of the region is difficult of access and almost uninvestigated.

Akuliaruseq. This classical locality of gieseckite which is constituted by all possible transitions between n. and muscovite has been mentioned in detail on p. 331.

Qeqertarssurssuaq (Laube 1870).

Vrba: Sitzb. d. k. k. Akad. des Wiss. Wien, 69, 1874, p. 69.

In an eudialyte-syenite which otherwise contains orthoclase, hornblende and eudialyte, a yellowish or greenish elæolite is found with a strong greasy lustre. Of rare occurrence crystals with $(10\bar{1}0)$ and (0001).

190. Analcite. $Na[AlSi_2O_6]H_2O$.

The Upernavik district.

Sukaussat (Rink). On fissures in black basalt together with chabazite, up to 1 cm in size. Rather clear and transparent with shining faces.

"The Continent" (RINK). Crystals (up to 5 mm) together with chabazite and calcite; rather clear and transparent.

The Umanak district.

Nakerdluk (GIESECKE 1811). Small, white regular crystals, interspersed among natrolite crystals.

Kilertinguit (STEENSTRUP 1881). Small, greyish crystals in small quantities among apophyllite crystals.

Qaersut (RAVN 1909).

RAVN: M. o. G. 47, 1911, p. 170.

Here mention is made of small crystals from the dykes of kaerssutite, and in a single case also from the surrounding peridotite.

Sangmissoq (ROSENKRANTZ 1939). Small (up to 5 mm) whitish crystals, in a schistose rock.

The Ritenbenk district.

Sarfarssuit (GIESECKE 10-7-1811). Recorded to have been found in "abgestumpften Würfeln"; it is not easy to say for certain what is meant by this; in any case the material at hand only consists of icositetrahedrons, 1—30 mm in size, dull greyish-white; the larger ones are somewhat decomposed and brownish.

Ingnangnaq (GIESECKE 8-7-1811, STEENSTRUP 1872). Reported by GIESECKE as found together with fibrous zeolites and stilbite. From STEENSTRUP's collections there are partly smaller crystals partly a single rather large crystal (6 cm in diameter) sometimes with well-developed faces; the colour whitish.

Ritenbenk Coal Mine (GIESECKE 18-7-1811). Recorded to be found together with aragonite and asbestus-like zeolite in basalt-tuff.

Nungerut (RAVN 1909). At a height of 223 m rather large (about 15 mm) and regular crystals have been found in cavities in basalt; at a height of 1265 m cavities with very small crystals.

Qutdligssat (STEENSTRUP 1872). Similar crystals as those mentioned from the preceding locality.

Ujaragssuit (STEENSTRUP 1872). Small (about 1 mm) clear colourless crystals; in adjacent cavities levynite was found.

Anartuarssuk (RAVN 1909). Small crystals in cavities.

The Godhavn district.

Brededal (STEENSTRUP 1872). Small greyish crystals together with chabazite; sometimes small cubic faces.

Igpik (O. R. B. HANSEN). Small whitish crystals.

Skarvefjeld (STEENSTRUP 1898). Crystals (5—10 mm) together with thomsonite and apophyllite.

Ũnartorssuaq (RAVN 1909). Small crystals (at most a millimeter in size) in cavities in basalt.

Akiarut (GIESECKE 14-5-1812). Greyish, semi-transparent crystals (about 1 cm). The faces peculiar in appearance, finely pitted and dotted with a brownish substance in the depressions.

Godhavn (PORSILD 1915). Crystallized together with natrolite and thomsonite; the conditions seem to be rather intricate, there being an older generation of a. after which radiating masses of natrolite have been segregated together with thomsonite; towards the middle it merges into pure natrolite, in which crystals of a. may be segregated, strongly penetrated by natrolite.

Kangerdluarssuk (RINK). Small (up to 5 mm) clear colourless crystals with calcite.

Qarssuanguit-qaqait. Small (2 mm) clear crystals together with chabazite and mesolite.

Qarusuit (STEENSTRUP 1872). A single rather large crystal (3 cm), fairly regularly developed. The faces rather shining, semi-transparent.

Qeqeq at Erqua in Disko Fjord (PORSILD 1916). In this locality, the actual situation of which is unknown, crystals up to 15 mm large and vitreous and colourless have been found. The faces shining, but rather curved; between them quite small thomsonite crystals.

Mellemfjord (PORSILD 1902). On the southern side of the fjord a smaller geode has been found lying in the gravel on the beach. The form peculiar in that the dodecahedron by far predominates, the icositetrahedron being quite narrow at some of the edges. The crystals somewhat dendritically developed. The faces shining.

The Julianehaab district.

Ipiutaq (STEENSTRUP 1909?). In this locality a great number of specimens have been found containing pseudomorphs, as far as can be seen of albite after analcite. The crystals are to be found on walls in cavities, and it seems that they are similar to the surrounding rock, consist of the same highly altered substance, a whitish, quite fine-grained mass which under the microscope proves to be quite impure, but as far as can be seen by far the greater part is albite. On the surface of the crystals there is a very thin layer of rock crystals. The pseudomorphs are 1—2 cm in size. Even though the faces are very uneven it

is, however, sure that the form is that of a icositetrahedron, and they may have been both garnet and leucite, even though analcite seems the most probable. It must however be observed, that the locality is not in the nepheline-syenite area, where a. is a common mineral, but in the red sandstone, though not particularly far from the nepheline-syenite.

Narssârssuk (FLINK 1897).

FLINK: M. o. G. 14, 1898, p. 232.

FLINK: M. o. G. 24, 1901, p. 106.

Found on felspar and ægirine in the pegmatite veins together with natrolite, calcite, rhodochrosite. The crystals (up to 1 cm) are clustered in crusts, the faces shining. The colour of the crystals is enamel-white, in the irregular individuals frequently yellowish.

The region of Kangerdluarssuk (GIESECKE 3-9-1806).

DESCLOIZEAUX: Bull. Soc. Min. de France, 7, 1884, p. 78.

LORENZEN: M. o. G. 7, 1893, p. 8.

USSING: M. o. G. 14, 1898, pp. 103, 118, 135, 141, 169.

FLINK: M. o. G. 14, 1898, pp. 238, 245, 258.

Found in very large quantities in the nepheline-syenite and its pegmatite veins it chiefly occurs in three forms, as crystals, in irregularly formed individuals and as pseudomorphs.

1. The crystals are found on the walls of cavities in the pegmatite, as a rule not accompanied by other minerals. They may vary from a few millimetres to very considerable sizes; a single fragment attains 13 cm in diameter and undoubtedly only constitutes a small part of the crystal. The faces may be shining, but also very uneven, more particularly on the larger crystals; the degree of the transparency varies greatly.

2. The irregularly shaped individuals may also attain a very considerable size (1 dm or more) and have a very strong cubic cleavage or parting. They are very pure with the exception of a few intergrown ægirine crystals. The colour is white or greenish. The optical properties have been examined by DESCLOIZEAUX and are, for that matter, hardly different from those described by BRÖGGER (Zts. Kryst. 16, 1890, p. 565). Lamellae parallel with (100) are the most common, but they are also obliquely parallel with (111) or (110). The single individuals must, as also pointed out by BRÖGGER, have a triclinic symmetry, as there is nowhere a parallel extinction; but conditions are extremely irregular, and besides polysynthetic twin formation in the proper sense of the word also optical anomalies seem to make themselves felt. DESCLOIZEAUX calls the mineral by the name of eudnophite, which is a very pronouncedly birefringent form of a. An analysis has been undertaken by LORENZEN: SiO_2 54.80, Al_2O_3 23.61, Na_2O 14.52, H_2O 8.25 = 101.18.

3. Pseudomorphs are very widely distributed; according to Ussing they have been produced by alteration of the following minerals:

a. Felspar. Both microcline and albite are altered, the latter most easily. The alteration takes place from the margin of the individuals or from fissures. A. is white, sometimes fine-grained, sometimes with large individuals, which may penetrate several felspar individuals.

b. Nepheline. This alteration is a very common one, more particularly in the fine-grained nepheline-syenites; a. may also be more or less fine-grained.

c. Sodalite. The alteration process will be mentioned under this mineral.

d. Eudialyte. The occurrence of a. in this locality is mentioned under eudialyte (p. 249).

East-Greenland.

Henry Land (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 115.

Crystals (up to 15 mm) nearly filling out cavities in basalt. Transparent or semi-transparent.

Turner Sund (O. Nordenskjöld 1900).

Bøggild: ibid.

Small (up to 4 mm) crystals found in great quantities in cavities. The faces well-developed, shining.

Kap Brewster (O. Nordensjköld 1900).

Bøggild: ibid.

Crystallized (1—10 mm) partly together with calcite. The smaller crystals are greyish, semi-transparent, the larger ones white, opaque with curved faces.

Steensby's Bjerg on the northern coast of Hold-with-Hope (Sig. Hansen 1929). At a height of 400 m analcite crystals have been found on radiating masses of mesolite and thomsonite, penetrated by thin needles of the first-mentioned mineral. In one case a. forms a 15 mm thick crust on the surface of which there is a layer of closely packed small crystals (about 2 mm); in another case scattered larger crystals (up to 2 cm) are found. A. is white, opaque.

(Leucite).

Ussing[1]) and Rosenbusch[2]) mention an originally leucite-bearing rock, viz. arfvedsonite-leucite-granite, which forms narrow veins in the nepheline-

[1]) M. o. G. 14, 1898, p. 109.

[2]) Elemente der Gesteinslehre, 1898, p. 215.

syenite at Kangerdluarssuk, the Julianehaab district. However, the entire mass of leucite has been altered into analcite.

191. Orthoclase. $K[AlSi_3O_8]$.

Among the Greenlandic orthoclases from the pegmatite veins only one (Langø) is a pure o., while the four others (Upernavik, Qôroq, Niaqornârssuk and Narssârssuk) are perthitic.

The Upernavik district.

Langø (Troelsen 1939). Irregularly formed individuals (up to 6 cm) in graphite. Clear and transparent, of a faint brownish colour. Angle of extinction on (010) is 6°.

The Umanak district.

Anoritoq.
Rink: Gr. I, 2, p. 215.
Here o. is mentioned in perfect and distinct crystals, which are the only ones of that kind found in North-Greenland. The samples in the Danish collections, which by Rink have been termed o., are, however, at any rate apatite.

The Sukkertoppen district.

Upernavik in Isortoq (Lytzen 1875). Black-greyish fragment (about 4 cm) with a very regular perthitic structure. The obliquity of extinction is unusually small (1—2°).

The Godthaab district.

Kanajorssuit (Giesecke 30-7-1808).
Leonhard: Handbuch d. Oryktognosie, 1826, p. 428.
Here adularia is reported to have been found.

The Julianehaab district.

Qôroq, north of — (Ussing 1900). The finding place is reported to be the nepheline-syenite on the northern side of the peninsula, north of Qôroq, and it is the only mineral collected in the nepheline-syenite in the large Igaliko batholite. The felspar is either dark-grey, more transparent or whitish, opaque. In sections parallel with the base a rather irregular perthitic structure appears which, however, shows two very characteristic features; there are a number of very thin albite lamellae in the usual direction (horizontal) and a great number of thicker lamellae, which upon the whole have a right-angled direction (vertical). On (010) the obliquity of extinction is about 7°.

Niaqornârssuk (Ussing 1900). The material at hand is the only sample of pegmatite in the augite-syenite, extending along the western

side of the above-mentioned nepheline-syenite, seeing that in this context it is necessary not to include the famous occurrence of Narssârssuk, the origin of which undoubtedly has its own history. The felspar is found together with smaller quantities of augite and other minerals, and it is dark-reddish-grey in colour. In sections parallel with (001) it bears so far a great resemblance to the felspar from Qôroq, as also there are a great number of quite thin albite lamellae in the usual direction, whereas the broader areas with a vertical orientation are lacking.

Narssârssuk.

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 208. — Zts. Kryst. 23, 1894, p. 365.

Ussing: M. o. G. 14, 1898, p. 43.

Flink: M. o. G. 14, 1898, p. 228.

The potassium felspar from N. constitutes, together with ægirine, the main mass of the pegmatite dykes; for the greater part the felspar is found in the form of irregularly bounded individuals, but there are also a number of crystals which are sometimes very finely developed. The faces are the usual ones (001), (010), (110), (130), ($\bar{1}11$) and ($\bar{2}01$), often twins according to the Carlsbad law. The faces may be very plane and shining, but (110) is most frequently overgrown with albite, whereas many crystals are entirely enclosed in this mineral, which continues the growth of the potassium felspar. The colour is whitish or greyish.

The microscopical examination reveals a structure which must be said to be in high degree peculiar. After my experience the two felspars, orthoclase and microcline, are intermingled with eachother in such a manner that both of them may be found in the same small preparation. They differ highly from each other, the orthoclase possessing a very fine and regular structure, the microcline a very coarse and irregular one, and there is no transitions between them.

Most of the forms of orthoclase have been described by Ussing who, however, holds them to be microcline; I cannot see that the arguments of Ussing for that supposition are sufficient, and Ussing never possessed material of that form of microcline, which is especially characteristic of that locality.

There are several kinds of structures:

1. This has been described by Ussing, pp. 43—53, and pictured on his pl. II, fig. 2, and IV, fig. 1. On sections parallel with (001) we see vertical (parallel with the *a*-axis) striae, which send out quite short columnae of orthoclase and albite, interchanging; these columnae are broken up into quite thin oblique striae, which form an angle of about 52° with eachother and of about 64° with the vertical striae. These

oblique striae are so fine that they are only visible when greatly magnified, for which reason Ussing terms the system crypto-perthite.

2. Related with the preceding is the felspar described by Ussing on pp. 53—60 and pictured on this pl. III, fig. 1 and IV, fig. 2, and on our fig. 70. Here the vertical striae are replaced by very regular albite lamellae; the horizontal layers of o. and albite are essentially longer

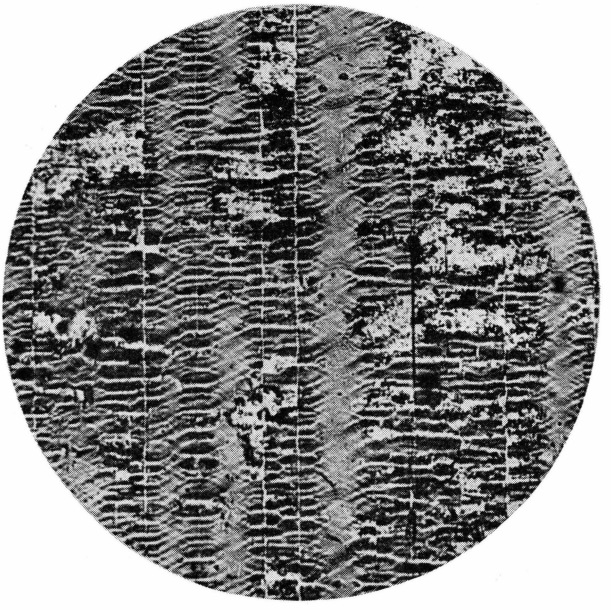


Fig. 70. Orthoclase-perthite. Narssârssuk. C. 80:1. Nic. +.

and constitute the greater part of the whole, while the cryptoperthite is reduced to thinner vertical bands.

3. However, it is possible in these felspars to find areas in which the oblique layers are of much larger dimensions (fig. 71), but otherwise very regular and with the same angles as those mentioned above; here it clearly appears that the kali-felspar consists of orthoclase.

4. This rather common form resembles very much the former in having oblique bands of albite, but the directions are rather irregularly curved and bent in different manners, as described by Ussing, pp. 38—42, and pictured in his pl. II, fig. 1.

The felspar No. 2 has been analysed by Detlefsen (in Ussing): SiO_2 65.81, Al_2O_3 19.43, Fe_2O_3 0.40, K_2O 8.66, Na_2O 5.61, loss at ign. 0.39 = 100.30.

Naujakasik (Steenstrup 1888).
Ussing: M. o. G. 14, 1898, p. 19.

Found in the form of orthoclase-microperthite as secondary constituents in a foyaitic rock.

Igaliko (STEENSTRUP 1875). Phenocrysts in red porphyry; the size 0.5—2 cm. The crystals completely developed, as a rule tabular

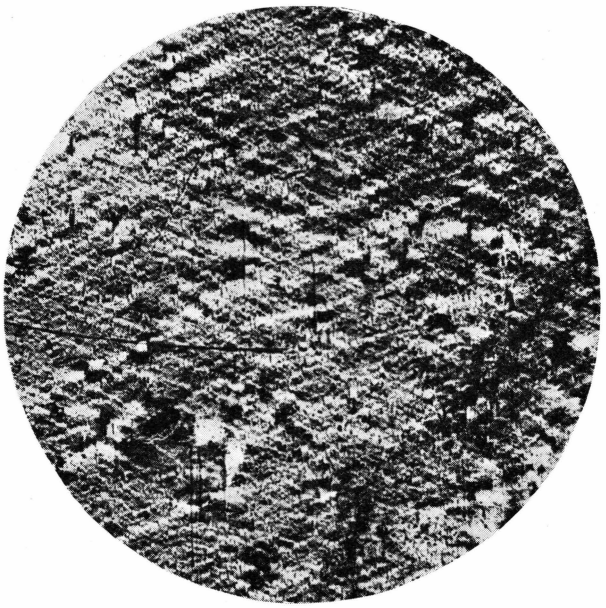


Fig. 71. Orthoclase-perthite. Narssârssuk. C. 80:1. Nic. +.

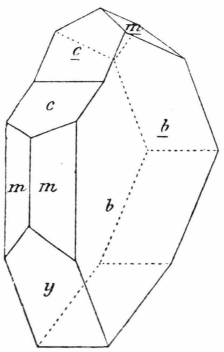


Fig. 72. Orthoclase. Twin along ($\bar{2}01$). Igaliko.

parallel with (010). Combination: *b* (010), *c* (001), *m* (110), *y* ($\bar{2}01$). Either single crystals or Carlsbad twins; in a few cases twins were found with twin planes ($\bar{2}01$), such twins being otherwise extremely rare and never found so regularly developed (fig. 72). The faces are well-developed and plane, but very dull. The colour is red. The interior is very impure,

so that only very thin sections are fairly transparent; there is not the least trace of any perthite or microcline structure. The angle of extinction is 7—8°.

192. Soda-orthoclase. $(K,Na)[AlSi_3O_8]$.

There are known 5 occurrences, all with the characteristic light reflexion.

The Godthaab district.

Aliortoq (Giesecke 23-5-1810).

Bøggild: K. D. Vid.-Selsk. Mat.-fys. Meddelelser, VI, 3, p. 12.

Cleavage fragments (up to 1 dm) together with hornblende; the colour impurely brownish or greyish. Fairly transparent and sends out a rather strong light-blue reflection from a face, which is as usually situated as an orthodome in the region of $(\bar{8}01)$, $(\bar{7}01)$ and $(\bar{6}01)$; in the felspar from A. the angle is towards (001) 72°44′. The obliquity of extinction is 11°50′. Under the microscope neither microcline nor perthite structure is visible.

Possibly from the same locality are some samples present in the Mineralogical Museum of Copenhagen, originating from the time before Giesecke; at any rate they greatly resemble them in all respects. Owing to their strong reflection they have been noticed by various investigators, and they are mentioned both by Abildgaard[1]) and Schumacher[2]); the specific gravity is recorded at 2.5 and 2.553 respectively.

The Frederikshaab district.

Kûnait (Giesecke 13-8-1809).

Bøggild: l. c. p. 11.

In all essentials resembles the preceding locality. The reflecting face forms an angle of 72°40′ with (001); angle of extinction 11—13°.

The Julianehaab district.

Siorarssuit (Steenstrup 1888).

Ussing: M. o. G. 14, 1898, p. 60.

The mineral is a constituent of the augite-syenite in the Kangerdluarssuk area; the only somewhat larger fragment originates from S., though it does not appear, whether it is North or South S. The mineral is greyish, rather fresh, with a reflecting face, parallel with which there may be a parting. The obliquity of extinction is $11^1/_2$—12°. According to Ussing the microscopical structure is generally homogeneous, but

[1]) Naturh. Selsk. Skr. 2, 1792, p. 126.

[2]) Versuch eines Verzeichnisses der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien, 1801, p. 82.

in the direction of some opaque striae consisting of kaoline or muscovite there are areas of cryptoperthite. As to further details see USSING.

Narssârssuk.

BØGGILD: l. c. p. 11.

In one of the many collections from this place, brought in by Greenlanders during the first years after FLINK's travels, there were also some samples of felspar, which might with a certain justification be said to be the most beautiful mineral of Greenland. Whether it is really from N. or from the last-mentioned locality, cannot be determined for certain. The samples were unconnected with other minerals with the exception of a barkevikite, which may originate from both localities. The felspar is semi-transparent, brownish or colourless and with a fine azure reflection, the strength of which is somewhat varying. The reflecting face forms an angle of 72°18′ with (001), and almost in the same direction there is a parting the strength of which may sometimes be very striking, but on closer investigation it always appears that it differs by several degrees from the reflecting face and has a quite irregular crystallographical position. The obliquity of extinction is 10°30′; when viewed under the microscope there is as a rule no trace of any visible structure.

Amitsoq (GIESECKE).

GIESECKE: Catalogue of Minerals, p. 202.

Greatly resembling the preceding ones. The colour impure, greyish or brownish; blue, opalescent reflection; no structure visible under the microscope. Obliquity of extinction 13°.

193. Microcline. $K[AlSi_3O_8]$.

In Greenland (as elsewhere) a distinction may be made between two kinds of microcline: 1) the common, cross-hatched m. ("secondary microline") and the much rarer, not cross-hatched m. ("primary microcline"). There is no transition between the two classes and both kinds are never found in the same locality.

To the primary microclines belong the four localities Ivigtut, Narssârssuk, Kangerdluarssuk and Nalagûtoq; it is probable that the rocks of those places all belong to what is commonly called "younger eruptives" (about the latter locality, however, nothing is known); but for that reason we cannot conclude that all newer eruptives contain that kind of felspar. If we consider the three well examined nepheline-syenite batholites in Greenland, it is very peculiar that one of them, Grønnedal near Ivigtut, contains secondary microcline, another, the Ilimausaq-batholite (the same as the region of Kangerdluarssuk) primary microcline and the Igaliko-batholite (outside Narssârssuk) only orthoclase.

All other Greenlandic microclines belong to the secondary class; in the following are described more than 40 localities i. e. more than all other pegmatite felspars together. One locality, Kingigtoq, possesses a microcline, which

only partly belongs to that group, while the main mass of it stands perfectly apart.

All the microclines are perthitic, but the amount of albite may vary very much, and in some places, especially at Ivigtut, it is reduced to a minimum.

The Thule district.

Littleton Ø (KRARUP-SCHMIDT 1881). A cleavage fragment (5 cm) with quartz and biotite. The colour dark reddish-grey. Very fine microcline and microperthite structure, nearly bordering on the invisible.

The Upernavik district.

Upernaviarssuk (GIESECKE 1807). Of the nature of graphic-granite with sizes of individuals up to 1 dm. The colour greyish-white. Fine, rather irregular microcline and microperthite structure; one of the microcline individuals hardly developed.

Langø (RINK).

RINK: Ngr. p. 42.

In most respects very much resembling the preceding locality.

The Umanak district.

Agpat (JANUS SÖRENSEN 1931). Reddish-white graphic-granitic felspar with a very regular microcline structure; albite bands with a very irregular course.

Satúnguit (GIESECKE 1811). Large individuals (up to 15 cm) with interspersed titanite crystals together with biotite. The colour greyish. Fine microcline and microperthite striation, one of the microcline individuals almost entirely lacking.

The Godhavn district.

The Godhavn peninsula (GIESECKE). Reddish-grey, coarse graphic-granitic felspar. Regular microcline structure. Rather small quantities of albite.

Upernavik Næs (GIESECKE 12-6-1812) and Fortunebay (22-3-1813). Here mention is made of avanturine felspar. It is a semi-transparent felspar of a reddish or greyish colour; under the microscope a very fine microcline and microperthite structure. Strong reflection of the light in a single direction from numerous small points.

Sermersoq in Disko Fjord (GIESECKE 6-9-1811). Here mention is made of avanturine with a golden tinge.

The Christianshaab district.

Bings Hul at Isua (GIESECKE 1-10-1807). Reddish white felspar (in G. "in Adular übergehend"). Regular, rather coarse microcline structure, in some cases with almost only one individual; coarse, very irregular perthite structure.

Suilaussaq (RINK). Red or whitish felspar; sometimes in the nature of a graphic granite, sometimes with small garnets enclosed in it. The structure as in the preceding locality.



Fig. 73. Microcline-perthite. Akunâq. C. 33:1. Nic. +.

The Egedesminde district.

Akunâq, west of — (SYLOW 1883). Red felspar with quartz and muscovite. Coarse microcline structure with one of the individuals reduced to a few vertical striae (parallel with the *a*-axis). The angle of extinction on (001) is 16°, on (010) 6°. Coarse, microscopical very striking perthite structure.

Qaqortoq (SYLOW 1883). Reddish or greyish felspar with quartz and biotite; strong pearly lustre on (001). Fine microcline structure, double perthite structure with a few coarse and numerous very fine albite lamellae.

Akugdlît (GIESECKE 1812). Cleavage fragments of a reddish felspar without other minerals. The microcline almost only consists of one individual; the other one is exclusively found developed in a few

quite small areas, where there is a cross-striation. Very coarse perthite structure.

Sungaussaq (GIESECKE 16-8-1812).

DESCLOIZEAUX: Ann. de Chim. et Phys. 5, sér. 9, 1876.

SYLOW: M. o. G. 8, 1889, p. 28.

Judging by the numbers and sizes of the samples brought home (up to 2 dm) it must be a considerable occurrence. In a fresh state the



Fig. 74. Microcline-perthite. Inugsulik. C. 33:1. Nic. +.

felspar is pale-greenish of colour and rather transparent. The outer parts are brownish or yellowish, untransparent. The structure has been described and figured by DESCLOIZEAUX; on basic sections are seen long, horizontal bands (parallel with the *b*-axis) consisting of albite and the one microcline individual interchanging, whereas the other one forms very scattered and small vertical streaks in it. DESCLOIZEAUX has determined the specific gravity at 2.584. Analysis by DAMOUR (in D.): SiO_2 65.43, Al_2O_3 19.58, Fe_2O_3 0.35, K_2O 12.45, Na_2O 2.31 = 100.12.

Very peculiar is a red felspar collected by PJETURSSON in 1897. In sections parallel with (001) the greater part of it consists of the one microcline individual in which a few small streaks of the other one are visible; the albite is shaped like irregularly rounded masses, which also applies to sections parallel with (010).

Inugsulik (GIESECKE). From here there are two samples, which are entirely like each other as to their light reddish-grey colour and

their semi-transparent consistency, whereas the microscopical structure is quite different. The one has a fine and regular microcline- and microperthite-structure, the other one a double perthite-structure (fig. 74), there being coarser lamellae up to 0.2 mm wide and with a distance of about 2 mm from each other and between them numerous fine lamellae; there is hardly any microcline structure, as the one individual has been reduced to quite few and small streaks. It has thus been possible to determine the angle between (001) and (010), which was 89°37′ (89°31′—89°49′). The angle of extinction on (001) is 16°, on (010) 6°.

Tinutekasak (PJETURSSON 1897).

PJETURSSON: M. o. G. 14, 1898, p. 289.

Together with biotite; semi-transparent with violet-grey colour and a strong bluish pearly lustre on (001). Fine microcline and microperthite structure; in base sections the albite has the form of very short rectangular plates.

Simiutarssuaq (PJETURSSON 1897). A grey felspar together with quartz and biotite. Regular microcline and perthite structure.

Ikerasarssuk (PJETURSSON 1897). Fragment of a large crystal, intergrown with quartz. The faces (001), (010), (130) and ($\bar{2}$01) extremely uneven; the colour light-reddish and greyish. Structure like that of the preceding occurrence.

Agto (PJETURSSON 1897). Rather large cleavage fragments of a violet-grey felspar with a strong pearly lustre on (001); regular microcline- and microperthite-structure.

The Holsteinsborg district.

Igdlorssuit (S. HANSEN 1888).

Cleavage fragments together with biotite. The colour violet-red with a strong violet-blue pearly lustre on (001); further, gold-glistening avanturine shells are visible through the faces of (010). Fine regular structure.

The Godthaab district.

Godthaab. This is the label on some crystals of an amazon-stone present in the Mineralogical Museum of Copenhagen and collected in the older times, before 1800. As neither GIESECKE nor any other of the many, who on later occasions have travelled in the district, have found this mineral, it is likely to suppose that it comes from Nunarssuit. Godthaab, which is the "capital" of the country, can easily have been given as place of occurrence instead of another locality. As the mineral itself otherwise bears a great resemblance to the one from Nunarssuit it is not to be mentioned in detail in this context.

Qasigianguit at Ameralik (Nyeboe 1915). A light yellowish felspar with a double perthitic structure, partly coarse, regular lamellae and partly, between them, numerous fine lamellae. The microcline structure very characteristic; the one individual occupies by far the greater part of the mass, whereas the other one has been reduced to numerous lamellae, which are to be found on the albite-lamellae and further extend for a shorter or longer distance into the main individual, terminating in fine points.

Aliortoq (Giesecke 23-5-1808). Here there are various kinds of m. The one is whitish-grey, only little transparent, with a strong pearly lustre on (001); rather fine and regular microcline and microperthite structure. The other one is brownish-red, transparent, also with a strong lustre on (001). In sections parallel with (001) a similar structure is seen as that mentioned from Sungaussaq, viz. horizontal striae consisting alternately of albite and the one microcline individual, whereas the other one is hardly to be seen.

Qarajap Ilua (Steenstrup 1888). A felspar of a reddish-white colour with the usual structure.

Kilingarssuaq (Rink). Found together with quartz, oligoclase, allanite and zircon. A single large individual (about 2 dm) is intergrown by quartz with the columnae of the quartz placed in the direction of the *a*-axis of the felspar. The colour whitish, the structures the usual ones.

Ikâtoq (Giesecke 1809). Whitish-grey felspar with a strong pearly lustre on (001); the structures the usual ones.

The Frederikshaab district.

Kangarssuk (Rink). In all essentials very much resembling the felspars from the immediately preceding localities.

Ivigtut (Tayler).

Tayler: Quart. Journ. Geol. Soc. London, 12, 1856, p. 142. — Manual of Greenland, p. 345.

Rink: Gr. II, App. p. 149.

Johnstrup: 12. Skand. Naturforskaramötets Förh. Stockholm, 1880, p. 239.

Bøggild: Zts. f. Kryst. 48, 1911, p. 470.

Found in the pegmatitic mass which like a shell surrounds the main mass of the cryolite and, particularly on the western side, extends to a thickness of 30 m. In addition to quartz and felspar this pegmatite contains mica (ivigtite), black cryolite, fluorite, molybdenite, columbite, arsenopyrite and zircon, besides the other ores found in the main mass

of the cryolite. The age of the felspar in relation to the other minerals is very varying; as a rule the cryolite surrounds it and often penetrates into fissures in the felspar. On the subsequent washing out of the cryolite the felspar is separated from it, and then presents a very peculiar appearance with a grooved and pitted surface and most uneven and rough faces. The most usual combination is (010), ($1\bar{1}0$), (110), (001) and ($\bar{1}01$), sometimes supplemented with small faces of ($\bar{1}11$) and ($\bar{1}\bar{1}1$). Twins occur sometimes, more particularly Baveno- but also Carlsbad- and Manebach-twins.

The colour is reddish-yellow. The microcline structure is peculiar in that the two individuals, generally of an equal weight, do not show the usual grating structure on sections parallel with (001); it is true, there seems to be a cross striation, but the boundaries are greatly undulating and sometimes quite irregular (fig. 75), so that there is a rather great resemblance with the felspar described by Ussing from the Kangerdluarssuk area (as to this see below). In sections parallel with (010) is seen a quite small amount of albite, in the form of narrow striae in the usual direction. An analysis undertaken by Lorenzen (in Johnstrup) shows about 17 % K_2O, that is, the amount to be found in the entirely pure potash felspar. It is more peculiar that such a felspar occurs in a mass so rich in soda as the cryolite massif.

When investigating in greater detail the projections on the surface of the crystals, it appears that many of them are clear and transparent, and it proves that they frequently consist each of a single microcline-individual forming an immediate continuation of one of the two individuals within the crystal. These projections, from one to a few mm in length, can be measured and are thus a valuable contribution to the determination of the crystallographical elements of the microcline crystals. In sections I have found a sharp boundary between the twinned and the single m. in the vicinity of black cryolite (fig. 75), but on the other hand I have seen in another section a perfectly gradual transition between both microclines near a boundary to a quartz vein.

The Julianehaab district.

Nunarssuit (Giesecke 7-8-1809).

Haughton: Phil. Mag. 32, 1866, p. 221.

Here there are undoubtedly two different occurrences.

1. Larger quantities together with quartz and small quantities of biotite; a few very imperfectly developed crystals (010), (110) and (130). The colour sometimes a vivid green (amazon stone), but from here there are all possible stages of transition to yellowish or greyish areas. In sections parallel with the base the microcline is seen to be by far the prevailing one, consisting of one individual with very little cross-stria-

tion. Perthite structure with comparatively small quantities of plagioclase, forming irregular figures, which however have a tendency to form oblique striae.

2. Smaller quantities of felspar together with arfvedsonite and a little quartz; it may be supposed that it is here a question of alkaline rocks, which have however not yet been investigated in detail. The felspar is inconsiderable of a yellowish colour. The sections show hori-

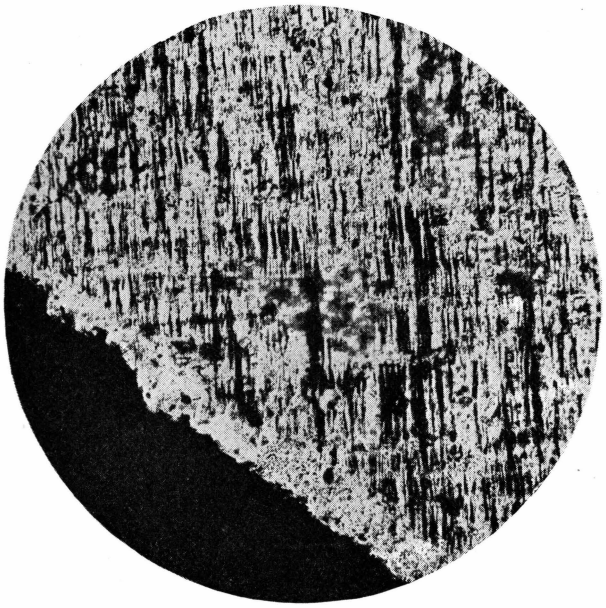


Fig. 75. Microcline. Ivigtut. The black area is cryolite. C. 80:1. Nic. +.

zontal striae, m. and plagioclase interchanging; m. is practically only developed in one individual; the amount of the two kinds of felspar is nearly the same.

HAUGHTON's description is not provided with any other indication of locality than "Greenland"; the analysed mineral is called "green orthoclase" and is sometimes referred to Kangerdluarssuk (e. g. in HINTZE's Mineralogy). However, the colour from this locality is not a particularly strong green, and the amount of soda found is rather small. It seems the most probable that the mineral investigated is the amazon stone, and that it originates from Nunarssuit. The analysis shows: SiO_2 64.40, Al_2O_3 18.96, Fe_2O_3 1.04, CaO 0.45, MgO 0.14, K_2O 13.07, Na_2O 2.35 = 100.41.

A green prismatic felspar crystal mentioned by ABILDGAARD (Nat. Selsk. Skr. 2, 1792, p. 128) must presumably also originate from this locality.

Nunarssuit, neighbourhood of — (Hoff 1853). Crystallized together with quartz and ægirine. The crystals (1—2 cm) very well developed, sometimes with faces developed in all directions, sometimes penetrated by ægirine needles. Combination (010), (110), (1$\bar{1}$0), (130), (1$\bar{3}$0), (001), ($\bar{2}$01), ($\bar{1}$11) and ($\overline{11}$1). The faces most frequently rather dull, the colour light yellowish-green, the microscopical structure essentially as in the preceding one.



Fig. 76. Microcline. Kingigtoq. C. 50:1. Nic. +.

Kingigtoq at Qagssimiut (Fritz.) A brick-red untransparent felspar which in its interior structure must be regarded as one of the strangest of all microclines. In sections parallel with (001) the greater part of the face seems to be built up of horizontal lamellae (according to the pericline law) without any trace of the otherwise prevailing vertical striae; the other striae are uncommonly regular (about 0.005—0.01 mm thick). But in some areas vertical bands appear, irregularly bounded towards the main part of the space, and here an ordinary cross-striated microcline structure is found. In fig. 76 we see, in the middle, one of these bands and to both sides of it the main structure of that felspar; in these parts there is a very pronounced alternation of vertical, lighter and darker bands. This is produced by one of the two alternating microcline individuals dominating over the other one in the one kind of bands and vice versa. In sections parallel with (010) the pericline-striation is also very distinct; striae form about 77° with the

trace of (001); the angle of extinction is 6°. The cross-striated areas contain some albite in irregularly shaped masses, whereas there is no trace of it in those horizontally striated.

Narssârssuk (STEENSTRUP 1888).

USSING: M. o. G. 14, 1898, p. 9, 38, and 44.

Concerning the occurrence of microcline in this locality and its relation to orthoclase report is given under that mineral, p. 362. The

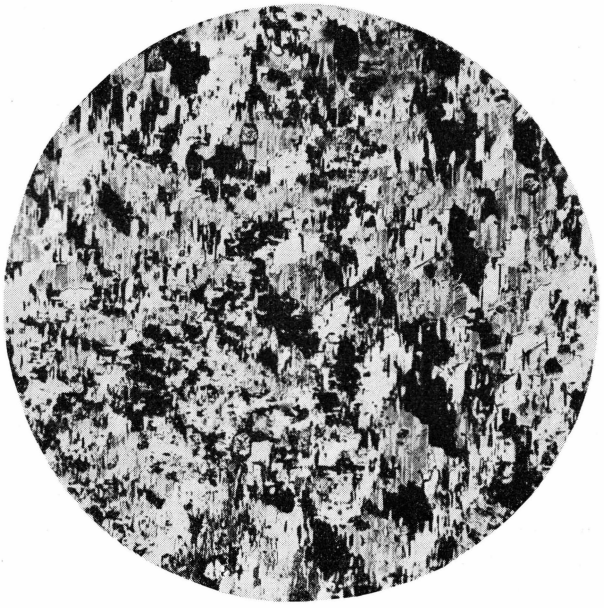


Fig. 77. Microcline-perthite. Kangerdluarssuk. C. 80:1. Nic. +.

building of the m. is as different as at all possible from that of the orthoclase, the structure being extremely irregular and at the same time in most instances very coarse; it seems that the three structure elements, i. e. the twinned albite and the two individuals of the m. are placed between each other quite at random, only excepting a few instances, where there is some resemblance to the m. from Kangerdluarssuk. As to the proportions of the m. and the albite there are all possible transitions between almost pure albite with only a few grains of m. and pure m. with small amounts of albite. USSING describes a pure m. of a very fine-grained structure; the label tells that the specimen originates from Igaliko, and it consists besides of the m. of a blue sodalite; as this mineral is not known from Narssârssuk it may possibly have had another origin.

South Siorarssuit (the BERNBURG expeditions 1903). Small crystals (1—2 mm) found in an altered rock, together with ilvaite

and hematite; the form is very peculiar; prevailing faces are (010), ($\bar{1}$01) and ($\bar{2}$01), less pronounced (001). The faces are rather dull and curved; the crystals somewhat imperfectly developed. The colour is pink, the substance opaque and very impure. The microcline structure sometimes irregular; sometimes the two individuals are arranged in vertical striae; there is no perthite-structure.

The region of Kangerdluarssuk (Giesecke 28-8-1806).

Breithaupt: Berg- und Hüttenm. Zeit. 17, 1858, p. 11.

Descloizeaux: Ann. de Chim. et Phys. 5. sér. 9, 1876, p. 8.

Lorenzen: M. o. G. 7, 1893, p. 9.

Ussing: M. o. G. 14, 1898, pp. 5 and 21.

Found in great quantities in the more recent eruptives and their pegmatite-veins; according to the thorough investigations of Ussing it essentially occurs in two forms:

1. Pure m. occurs as a rock constituent, essentially in the fine-grained lujavrites; in pegmatite it has been found at Kumerngit. In sections parallel with (001) mainly as vertical striae which, however, are to a very large extent irregularly bounded. The angle of extinction is 17.3°, on (010) it is 4.6°; the specific gravity 2.567. Analysis see below (No. 1).

2. Microcline-microperthite is a main constituent of the coarse-grained rocks and by far the greater part of pegmatite veins; developed crystals are rare and only have few and uneven faces. The individuals are about 0.5 m in size at Siorarssuit; the colour is greyish or greenish-white. It is undoubtedly this form of felspar, which is mentioned in the older literature; optical investigations have been undertaken by Descloizeaux and more particularly by Ussing. In sections parallel with (001) a very peculiar and characteristic structure is seen (fig. 77), cfr. Ussing's pl. I, fig. 1. The boundary lines between the two microcline individuals and between the latter and the albites having quite an irregular course; the twin boundaries of the albite are on the other hand as usual regular. The microcline shows a fairly pronounced tendency to arrange itself in directions which on both sides form angles of 25—30° with the *a*-axis. The specific gravity is determined at 2.580. Analyses of the pure microcline have been undertaken by Detlefsen (in Ussing, 1) of the perthite by Breithaupt (2), Lorenzen (3) and Detlefsen (in Ussing, 4).

	1	2	3	4
SiO_2	64.68	66.90	62.74	65.62
Al_2O_3	19.04	17.80	19.58	18.50
Fe_2O_3	0.24	0.50	—	0.55
MgO	tr.	—	—	tr.
CaO	—	0.60	—	—
K_2O	15.82	8.30	13.09	11.86
Na_2O	0.53	6.50	3.56	3.50
Loss at ign.	—	—	0.16	0.38
	100.31	100.60	99.13	100.41

Akuliarusiarssuk (Giesecke 1809).

Giesecke: Catalogue of Minerals, p. 201.

Pingel: Om den af Porfyrgange gennembrudte røde Sandsten, 1843, p. 18.

Crystallized (up to 4 cm) in porphyry together with gieseckite; a combination resembling cubes (001), (010) and ($\bar{2}01$) with small faces of ($1\bar{1}0$) and (110). The faces very rough and uneven, covered with mica-leaves etc.; in the interior strongly decomposed, impure with numerous enclosures. Under these circumstances it is almost impossible to decide whether the felspar is a microcline or an orthoclase.

Kinalik at Lichtenau (Rink). A graphic-granite, whitish-grey, opaque felspar. Coarse, regular microcline structure; numerous thin albite interpositions.

Nalagûtoq on Sermersoq, eastern corner of —. Small fragments of a beautifully green amazon stone. In basic sections is seen a rather irregular structure, which however bears a good deal of resemblance to the felspar from Narssârssuk, the mineral not having cross-hatching; both of the microcline individuals and also the albite grains are of casual shapes and intermixed at random.

Nanortalik (Eberlin 1885). Here a single small crystal (4 mm) has been found, and further somewhat larger masses of a whitish felspar together with muscovite, quartz, arsenopyrite, garnet and other minerals. Regular microcline structure; the albite interpositions in the basic sections frequently of a regularly rectangular form, now horizontally now vertically placed.

East-Greenland.

Qeqertarssuatsiaq at Aluk (Giesecke 1806). Whitish-grey felspar; regular microcline and perthite structure.

Dronning Louises Ø (Eberlin). White felspar in pegmatite, together with tourmaline and andalusite. Regular structure like the preceding mineral occurrence.

Nagtoralik (Eberlin). White felspar together with garnet, tourmaline and some quartz. Structure like the preceding mineral occurrence.

Karra Akungnait (Eberlin). White felspar in pegmatite; under the microscope it proves to be a nearly quite pure microcline with long vertical striae, crossed by a very few horizontal ones. Nearly no albite-interpositions.

Arferssuaq in Sermilik (Rüttel 1902). A large fragment of a rather strong red colour. Very numerous and partly very fine albite lamellae; the microcline almost exclusively vertically striated.

Clavering Ø? (ALEX. JENSEN). The specimen was unlabelled, but it was found in a shipment from this island. Light reddish-grey only slightly transparent felspar. In basic sections are chiefly seen rather broad and indistinctly bounded horizontal lamellae of the two microcline individuals, each of which is penetrated by very numerous and fine vertical striae of the other individual. Very irregular lamellae of a very impure and nearly untransparent albite.

Rypefjeld at Hvalrosodde (JARNER). A light-reddish opaque felspar in pegmatite. Under the microscope rather an ordinary structure is seen.

194. Soda-microcline. $(K,Na)[AlSi_3O_8]$.

The Julianehaab district.

The region of Kangerdluarssuk.

FOUQUÉ: Bull. Soc. de Min. de France 17, 1894, p. 421.

USSING: M. o. G. 14, 1898, p. 66.

According to USSING this mineral is found as a rock-constituent in augite-syenite, though only secondarily as compared with soda-orthoclase and cryptoperthite. As distinguished from the usual microcline from this region it shows in sections, parallel with (001), rectangular striae mostly vertical but also cross-striated. In sections normal to (010) USSING always finds small obliquities of extinction, but he states that the values cannot be accurate, owing to the extreme thinness of the lamellae.

FOUQUÉ describes a soda-microcline (microcline-anorthose) from Greenland. The specimen is greyish, transparent and originates from a pegmatite vein; as to the occurrence nothing can be said for certain; it may perhaps originate from the same locality as the preceding one. FOUQUÉ gives the obliquity of extinction on (001) as 88°, and on (010) as 7°. The axial angle, 2 V, is determined at 63°. From the data given it does not immediately appear that this felspar is a soda-microcline.

195. Albite. $Na[AlSi_3O_8]$.

The Ritenbenk district.

Ritenbenk (SYLOW 1883). In various fissures in a small fragment of gneiss two different forms of crystals were found. One of them was quite small (about 1 mm) of the usual form with (001), (010), (110), $(1\bar{1}0)$, $(1\bar{3}0)$, $(\bar{1}01)$, $(\bar{1}11)$ and $(\bar{1}\bar{1}1)$; albite-twins. The other kind was pericline twins, as usual elongated parallel with the *b*-axis; forms:

(001), (010), (110), (1$\bar{1}$0), ($\bar{1}$01). The faces of these crystals are dull and uneven; the crystals yellow and opaque. Specific gravity in both forms 2.631.

The Christianshaab district.

Bings Hul at Isua (Giesecke 1-10-1806 and 2-9-1812). Found in rather large crystal individuals (up to 6 cm) together with smaller quantities of muscovite; on walls in cavities are found small (1—10 mm) crystals, sometimes in a parallel position with the larger crystal individuals sometimes placed at random. The form is rather peculiar, elongated in the direction of zones (010): ($\bar{1}$01) and besides with the faces (001), (110), (1$\bar{1}$0), (130), (1$\bar{3}$0), (021), ($\bar{1}$11), ($\bar{2}$01). All crystals are twins; the larger finely striated. Most of the faces are well developed and shining, the crystals semi-transparent, greyish. The angle of extinction on (001) is 3—4°, on (010) about 18°; the specific gravity of the crystals is 2.614.

The Egedesminde district.

Manîtsoq (Rink). Coarse-grained with quartz; the colour light-greyish, very fine, nearly microscopical twin-striation. Specific gravity 2.621, angle of extinction on (001) 4° on (010) 15°.

The Frederikshaab district.

Arsuk Ø (Giesecke 1806). Small crystals (1—2 mm) in a fissure in granite together with crocidolite and rock-crystals, usual felspar form with the faces (001), (010), (110), (1$\bar{1}$0), (130), (1$\bar{3}$0), (021), (0$\bar{2}$1), ($\bar{1}$01), ($\bar{1}$11), ($\bar{1}\bar{1}$1); the faces rather shining; the crystals transparent and clear; specific gravity 2.632; extinction on (001) 4°, on (010) 19°.

The Julianehaab district.

Nyeboe's Kanal (Steenstrup 1888). The felspar forms a passage about 5 m broad on a small skerry. The colour is greyish-white; in thin sections the substance is very impure with a great amount of foreign constituents. Extinction on (001) about 3°, on (010) about 17°. According to the label the individual crystals must be able to attain a size of 1 cubic foot.

Narssârssuk (Lytzen's collection, 1893).

Flink: Geol. Fören. Förh. Stockholm, 15, 1893, p. 208. — Zts. f. Kryst. 23, 1894, p. 266.

Flink: M. o. G. 14, 1898, p. 228.

Goldschmidt und Dreyer: M. o. G. 34, 1910, p. 1.

Goldschmidt, Dreyer und Bøggild: N. J. f. Min. etc., Beilageband, 29, 1910, p. 537.

Found in very large quantities, crystallized in the pegmatite veins scattered about on the many different other minerals, and rarely lacking. The albite is very often found on the microcline crystals in parallel intergrowth, the microcline having continued its growth as albite. The individual crystals of this mineral are not particularly large, rarely exceeding 2 cm, but they are extremely well-developed, both rich in faces which in part are completely plane and reflecting, so that it has been possible, by means of these crystals, to determine the elements of the albite with greater certainty than by means of any other material. It must, however, be observed that GOLDSCHMIDT and DREYER also have subjected the material from Kangerdluarssuk to examination, and these crystals which otherwise greatly resemble those from Narssârssuk have given even rather better results. With certainty 34 forms have been determined, 8 of which are hitherto unknown. Apart from this see the treatise itself as to the details of these very exact, but also very extensive investigations.

The crystals are, at least for the greater part, clear and transparent; by far the greater part are colourless, but a few of them are of a beautiful rose colour. On a single one of those, which was sufficiently strongly coloured, the following pleochroism could be observed:

a and b colourless, c rose-coloured.

The specific gravity is 2.624; the obliquity of extinction on (001) is 3°, on (010) 17°. An analysis undertaken by CHR. WINTHER (in GOLDSCHMIDT and DREYER) is given below (1) together with an analysis (ibid) of the mineral from Kangerdluarssuk (2):

	1	2
SiO_2	68.80	68.80
Al_2O_3	19.40	19.43
CaO	0.20	0.00
K_2O	0.00	0.00
Na_2O	11.68	11.86
	100.08	100.09

The region of Kangerdluarssuk.
USSING: M. o. G. 14, 1898, p. 13.
FLINK: M. o. G. 14, 1898, pp. 238, 243, 247, and 257.
GOLDSCHMIDT und DREYER: l. c.
GOLDSCHMIDT, DREYER und BØGGILD: l. c.

Occurs as a constituent in the nepheline-syenites and also in the pegmatite veins, though in comparatively smaller quantities than at the preceding locality. In the ordinary pegmatite veins only once in

a while small crystals are found, and it is particularly under the two following conditions that larger quantities occur.

1. In the nepheline-syenite great quantities of granular albite sometimes occur, frequently in the shape of veins and sometimes following the ordinary pegmatite veins, having probably themselves to be regarded as a kind of it; they contain a number of rare minerals such as polylithionite, epistolite, schizolite and steenstrupine. The albite is snow-white, granular, the individuals 2—10 mm in size; the single individuals are tabular. The aggregate is rather loose with a great quantity of interstices, and sometimes somewhat larger cavities, in which crystals are projecting; the latter are flat, about 1 mm thick, 5—8 mm broad. As to the shape it is particularly noticeable that the prisms (110) and ($1\bar{1}0$) are very small, so that (130) and ($1\bar{3}0$) form the line of boundary in front and behind, those two together making a sharp wedge. The crystals are never rose-coloured, as mentioned above; the faces are rather more perfectly developed than on those from Narssârssuk. The angle of extinction is $3\,^1/_2{}^\circ$ on (001) as against 20° on (010). Analysis see above.

2. A large quantity of albite is found in the strongly metamorphosed rocks at South Siorarssuit, where there are also occurrences of ilvaite, epidote, granular fluorite etc. as it seems irregularly intermixed. The albite crystals are generally developed as small thin needles, and in most cases not particularly well developed.

East Greenland.

Angmagssalik (Rosenkrantz 1936). At the radio-station was collected a specimen of pegmatite, essentially consisting of a. together with smaller amounts of quartz and muscovite. Reddish-white, semi-transparent. Extinction on (001) 3°, on (010) 16°. Specific gravity 2.640.

Døde Hus Plads at Nualik (Kruuse 1899).

O. Nordenskjöld: M. o. G. 28, 1904, p. 13.

Small crystals (1—5 mm) together with epidote and rock-crystals in cavities in gneiss. Combination (001), (110), ($1\bar{1}0$), (130), ($1\bar{3}0$), (001), ($\bar{1}01$), ($\bar{1}03$), ($\bar{1}11$), ($\overline{1\bar{1}1}$), ($\bar{1}12$), ($\overline{1\bar{1}2}$). The faces rather dull and curved; untransparent and white in colour; the outer parts sometimes clear and transparent. Specific gravity 2.613, angle of extinction on (001) 3°, on (101) 18°.

Kap Arends ("Belgica" 1905). White masses in pegmatite together with quartz and tourmaline; the quartz forms veins 1—3 cm wide in the albite; the latter exclusively consisting of lamellae 0.5—1 mm thick, in twin position according to the Carlsbad law and also separate twins according to the albite law. The structure is, however, very irregular

with greatly curved faces, for which reason it is difficult to clear up the exact laws of intergrowth, in the same manner as it is difficult accurately to determine the angles of extinction. On (010) I have found about 20°, and so there can be no doubt that we are dealing with a rather pure albite. The specific gravity is determined at 2.624.

196. Peristerite. Albite — Anorthite (Ab : An = 12 : 1 — 6 : 1).

I have considered it expedient to record this mineral as an independent one, seeing that at least the Greenland occurrences form a rather isolated group, which must otherwise be placed on the very boundary between oligoclase and albite. The greater part shows a blue iridescence, which as a rule appears on the face (010) with which the reflecting face forms an angle of 14°; the crystallographic position of this face is not particularly far removed from (08$\bar{1}$).

The Egedesminde district.

Niaqornaq (Sylow 1883). Cleavage fragments of a white colour with reddish spots. The striation frequently very coarse. Specific gravity 2.636; angle of extinction on (001) 4°, on (010) 13°.

The Godthaab district.

Kanajorssuit (Giesecke 30-7-1808).

Leonhard: Handwörterbuch d. topogr. Mineralogie, 1843, p. 8.

Bøggild: K. D. Vid. Selsk. Mat.-fys. Medd. VI, 3, 1924, p. 33.

Whitish-grey, semi-transparent, graphic-granitic with biotite and garnet. Fine blue iridescence (in the direction common to these felspars). Specific gravity 2.631; angle of extinction on (001) 4°, on (010) $12^1/_2$°.

Hjortetakken (ɔ: the antler) (Giesecke 1808). In pegmatite together with biotite; the colour impure, reddish or greyish, strongly coated by rust. The directions of extinction 3 and 12°.

Aliortoq (Giesecke). Among the many different felspars originating from here there is also a sample of a reddish-grey, rather impure peristerite with a rather faint bluish iridescense. The obliquity of extinction on (010) is about 12°. Whether the felspars with iridescense mentioned a couple of times by Giesecke belong to this mineral or an orthoclase occurring in the same place, it is impossible to say.

The Julianehaab district.

Nunasarnaussaq (Giesecke 25-8-1806). Though this mountain is situated in the midst of the Kangerdluarssuk area, at the very fjord K., it is nevertheless doubtful, whether this occurrence may be classed here. It is a question of a p. of an impure, brownish-grey colour and with a blue iridescence; the extinction on (010) is 12°. A felspar of this kind is otherwise not known from the nepheline-syenite area,

nor has it been found by subsequent investigators. Still, GIESECKE writes: "Beträchtliche Lager von grünem zuweilen labradorisierendem Feldspath finden sich in dieser Gegend".

East-Greenland.

Kap Arends ("Belgica" 1905). A pegmatite consisting of reddish-white p. and quartz. The angle of extinction is about 12°, and it is not possible to see any opalescence.

197. Oligoclase. Albite — Anorthite (Ab : An = 6 : 1 — 3 : 1).

The Upernavik district.

Uigordlerssuaq (GIESECKE 1807). Found as graphic-granite in pegmatite, together with biotite. The colour greyish-white; specific gravity 2.654; angle of extinction on (001) and (010) very nearly 0°.

Grisebugt (GIESECKE 17-7-1807). Very indistinct and irregularly developed crystals (up to 3 cm) in magnetite. Specific gravity 2.646; angle of extinction on (001) 1°, on (010) + 6°. The colour reddish-white.

The Godhavn district.

Engelskmandens Havn (STEENSTRUP 1872). In pegmatite together with biotite. Specific gravity 2.653; extinction on (001) 1°, on (010) + 6°. The colour reddish-white.

The Egedesminde district.

Ikamiut (GIESECKE 6-9-1812). Rather large, semi-transparent cleavage fragments together with quartz, biotite, garnet and tourmaline, which minerals are frequently grown into the felspar. Specific gravity 2.661; obliquity of extinction can hardly be determined with certainty.

Manîtsoq (STEENSTRUP 1873). Coarse-grained together with diopside, actinolite and calcite. In cavities crystals (5—20 mm) with combination: (010), (110), (1$\bar{1}$0), (130), (1$\bar{3}$0), (001), (0$\bar{2}$1), (021), ($\bar{1}$01), ($\bar{1}$11), ($\bar{1}\bar{1}$1), ($\bar{1}$03), ($\bar{2}$01), ($\bar{2}$21), ($\bar{2}\bar{2}$1); the crystals flattened parallel with (001), the faces most frequently dull and striated; the colour greyish or whitish. Specific gravity 2.672, nearly parallel extinction on both faces.

Inugsulik (RINK).

RINK: Ngr. p. 44.

Large cleavage fragments, also graphic-granite of a whitish-grey colour. Nearly parallel extinction on (001) and (010). RINK states that

this felspar accompanies the allanite and has an appearance differing from the usual orthoclase, and that it is accompanied by a white graphic-granite.

The Godthaab district.

Aunikasik (FÆSTER 1944). Large individuals together with an amphibole, something between actinolite and hornblende. Light greyish, opaque or dark, rather clear; the cleavage planes rather irregular. Angle of extinction on both faces about 2°.

198. Andesine. Albite—Anorthite (Ab : An = 3 : 2 — 1 : 1).

The Upernavik district.

Nûluk (GIESECKE 22-7-1807). Small crystals together with a few biotite crystals enclosed in quartz. The form very indistinct; sometimes, however, a few of the ordinary faces could be distinguished. The faces dull and rounded the colour greenish-yellow. The interior of the crystals interlarded with small interpositions. Angle of extinction on (001) 2°, on (010) — 7°.

The Christianshaab district.

Eqaluit (RINK).

RINK: Gr. I, 2, p. 208.

Small crystals (about 1 cm) together with hornblende and anthophyllite. Combination: (010), (110), ($1\bar{1}0$), (130), ($1\bar{3}0$), (001), ($0\bar{2}1$), (021), ($\bar{1}01$), ($\bar{2}01$), ($\bar{1}11$), ($\overline{11}1$), ($\bar{2}21$), ($\overline{22}1$). The faces uneven and dull; the colour greenish- or yellowish-grey. Specific gravity 2.694; angle of extinction on (001) 4°, (010) — 12°.

Orpigsoq (GIESECKE 4-9-1812). Found in pegmatite; however, GIESECKE reports labradorite in granular limestone from this locality. The colour greyish. Specific gravity 2.680; extinction on (001) 3°, on (010) — 6°.

The Egedesminde district.

Manîtsoq (STEENSTRUP 1872). In pegmatite together with hornblende and biotite. Greyish, semi-transparent. Specific gravity 2.672; angle of extinction on (001) 2°, on (010) — 6°.

Agto (RINK).

RINK: Ngr. p. 40.

In pegmatite together with hornblende, garnet, quartz and diallage. The felspar is penetrated by fissures in many different directions, more particularly parallel with the prism faces; for the greater part clear and transparent and of a yellowish colour. Specific gravity 2.693; angle of extinction on (001) 4—5°, on (010) — 16°. The felspar thus approaches

greatly to labradorite. Numerous twin formations according to the pericline law.

Greenland without specified locality.

DESCLOIZEAUX: Bull. Soc. Min. de France, 7, 1894, p. 334.

Here is a description of a small white foliated felspar with fine twin striae. The angle of extinction on (001) about 2°, on (010) about 2—3½°. The mineral is thus on the transition stage between andesine and oligoclase. The optic axial angle ($2H_0$) is about 88°.

199. Labradorite. Albite—Anorthite (Al : An = 3 : 4 — 1 : 3).

The Egedesminde district.

Eqalugssuit (NYEBOE 1915).

BØGGILD: D. K. D. Vid.-Selsk. Mat.-fys. Medd. VI, 3, 1924, p. 62.

A small fragment together with some hornblende is all that has been found of this beautiful felspar; in some places it is clear and transparent, in others impure and dark; it has apparently a third cleavage direction, which forms a right angle with the two ordinary ones, but in measuring it proves that this direction in details has a rather varying and irregular course. In some places there is a very strong play of colours in blue and green, the reflecting face lies in the neighbourhood of $(04\bar{1})$, and the felspar thus belongs to the rarer group b. of labradorites. The angle of extinction on (010) is as far as the iridescent part is concerned — 19°, but in the colourless part it attains — 5 to —10°.

The Godthaab district.

Qasigianguit (GIESECKE 17-9-1808).

BØGGILD: l. c. p. 50.

A single small fragment without other minerals; dark-grey with a play of colours, in some places very strong, in blue, brown, and green; the reflecting face is in the neighbourhood of $(\bar{2}91)$, and the felspar belongs to the main group of iridescent labradorites. Under the microscope a number of impurities are seen, more particularly rectilinear interpositions parallel with the *c*-axis. Specific gravity 2.696, angle of extinction on (001) 7°, on (010) for the iridescent substance — 18 to —16°, for the colourless one — 14°.

Auvaitsersarfik (GIESECKE 1810). Partly as irregular grains together with gedrite and other minerals and partly also as quite small crystals in garnet. The crystals are as a rule irregularly rounded, but can also have the usual felspar form. Specific gravity is 2.730; angle of extinction on (001) about 15°, on (010) — 30°.

The Julianehaab district.

Josva's Copper Mine (Hoff 1853). A single larger cleavage fragment which by Hoff has been described as a vein. The felspar without enclosures, in larger samples generally black, in thinner plates transparent of a brown colour, which is unusually strong for a felspar. Specific gravity 2.703; angle of extinction on (001) 7°, on (010) — 20°. The dark colour disappears by ignition.

Itivdliatsiaq (Flink 1897). Like the preceding a large cleavage fragment, chiefly black, but the black colour interchanges with white striae of felspar, which has exactly the same orientation as the black one. As the two localities are very close to one another, it is possible that they may be identical.

Qagssimiut, from which there are a great number of cleavage fragments, collected by Greenlanders and unassociated with other minerals; the largest samples attain a weight of 1.5 kg. There are everywhere irregular transitions between areas, which are translucent with a brown colour and others, which are semi-transparent, brownish-white. Particularly pronounced is a parting parallel with (010), by which completely reflecting faces are produced; that there is no genuine cleavage appears from the fact that in the interstices between the twin-lamellae it is not possible to produce anything but most imperfectly developed cleavage planes. The angle of extinction on (001) is 6°, on (010) — 20°; there is no play of colours.

Narssârssuk (Nyeboe 1915). From here there are fragments of two kinds of labradorite; the one black and brownish or yellowish in transmitted light, the other light, brownish or yellowish, very impure with faintly projecting cleavage planes; angle of extinction on (001) about 5°, on (010) in the light-coloured l. — 18°, in the black — 21°. The labradorite is not accompanied by other minerals, and as it is otherwise quite unknown in this occurrence, where for that reason it cannot be supposed to be very probable, the indication of locality must, it seems, be regarded as doubtful.

200. Anorthite. $Ca[Al_2Si_2O_8]$.

This mineral is with certainty only known from the localities mentioned below. Here it must, however, be observed that a mineral latrobite (a form of a.) has been mentioned by Brooke (Thomson's Annals of Phil. 5, 1823, p. 383); it is reported to have been found on the island of Amitok on the coast of Labrador and has, without any special reason, been referred to Greenland in several manuals, viz. Breithaupt: Handb. d. Mineralogie, 3, 1847, p. 523 and Hintze: Handb. d. Mineralogie, 2, 1897, p. 1547 without further justification referred to Greenland.

The Ritenbenk and Godhavn districts.

Uivfaq and all the other localities, where metallic iron in situ has been found.

Nauckhoff: Bihang Vet.-Akad. Handl. Stockholm, 1, No. 5, 1872.
Steenstrup: Vid. Medd. Nat. Foren. 1875, p. 301.
Descloizeaux: Ann. de Chim. et Phys. 5. sér. 9, 1876, p. 59.
Törnebohm: Bihang Vet.-Akad. Handl. Stockholm, 5, No. 10, 1878.
Lawr. Smith: Ann. de Chim. et Phys. 5. sér. 16, 1879.
Steenstrup: M. o. G. 4, 1883, p. 113.
Lorenzen: M. o. G. 4, 1883, p. 133.
Nicolau: M. o. G. 24, 1901, p. 233.

Found in basalt in lumps of 2—5 cm; tabular parallel with (010). A. is so closely interlarded with small graphite shells that from a macroscopical point of view it looks rather like graphite; besides it contains small red grains of spinel and small brown glass-enclosures. The angle of extinction is according to Nicolau about 30° on (001), about 35° on (010). Because of the impurity the specific gravity cannot be accurately determined. Analyses undertaken by Nauckhoff (1—4), Smith (5) and Lorenzen (6):

	1	2	3	4	5	6
SiO_2	34.72	37.92	44.94	36.59	34.16	39.75
Al_2O_3	31.83	32.36	22.20	19.18	33.85	26.08
Cr_2O_3	—	0.08	—	—	—	1.23
Fe_2O_3	4.88	—	—	—	—	12.33
FeO	5.53	4.02	9.45	14.85	17.00	—
CaO	10.19	11.57	11.01	8.73	8.80	12.01
MgO	9.35	2.86	4.98	7.24	4.23	4.51
C.....	0.53	6.90	3.35	2.55	—	—
	97.03	95.71	95.93	89.14	98.04	95.91

The analyses show that the mineral is a very impure a.; the large contents of Mg and Fe possibly originate from spinel; the graphite in the last two analyses has been removed by washing.

There has been some discussion as to the nature of the felspar. Nauckhoff was of the opinion that it was most closely related to anorthite, whereas Steenstrup and Smith found that it was not dissolved by acids, and therefore classed it with labradorite. However, Lorenzen proved that the mineral was easily dissolved in hydrochloric acid, and after the optical investigation undertaken by Nicolau there is no doubt that it is anorthite.

The mineral described by Descloizeaux is reported to have been received from Giesecke; no locality is given, but D. himself is of the opinion that it must originate from one of the iron occurrences; the

various properties upon the whole agree fairly well with those mentioned above.

The Egedesminde district.

Akugdlît (Giesecke 1812, Sylow 1883). Rose-coloured masses occurring under very different conditions; in one case a. forms a layer or a vein in mica - schist, in another a vein (about 3—5 cm thick) in coarse-grained diopside; at the boundary between the two minerals there is a layer of smaller actinolite crystals. A. is chiefly fine-grained, but a number of individuals may attain a more considerable size (several cm). Under the microscope the substance is extremely impure, frequently nearly entirely penetrated by very small, strongly birefringent particles, probably mica. There is only in few instances found any twin striation, for which reason it is not easy to determine the directions of extinction. On both faces they are, however, found to be very nearly 30°. The specific gravity is determined at 2.685, which is a little less than is usually the case; the average refraction is very nearly that of the aniline (2.58). With hydrochloric acid a very strong gelatinization.

201. Cancrinite. $(Na_2,Ca)_4[CO_3(H_2O)_{0-3}(AlSiO_4)_6]$.

The Frederikshaab district.

Tuapatsiat (Holst 1880).

Törnebohm: Geol. Fören. Förh. Stockholm, 6, 1883, p. 696.

Found in a syenitic intrusive rock in the form of small granular aggregates; is for the greater part an alteration product of nepheline.

Grønnedal (Holst 1880).

Törnebohm: l. c. p. 695.

Found in the shape of larger radiating aggregates in a fine-grained syenite. The single crystal individuals may attain a length of 2 cm and a width of 3 mm. The outlines in cross-section are as a rule jagged and irregular, sometimes however hexagonal. C. is extremely closely interlarded with small crystals and grains of felspar, ægirine, biotite and apatite.

The Julianehaab district.

The region of Kangerdluarssuk.

Ussing: M. o. G. 14, 1898, p. 113.

Alteration product of nepheline, but comparatively rare and only in microscopically small quantities; complete metamorphoses have not been found. C. forms small irregular individuals, which singly or more frequently in fine-grained or radiating aggregates occur at the boundary plans of the nepheline-grains or in the fissures of the latter.

202. Leifite. $Na_2[FAlSi_5O_{12}](?)\frac{1}{3}H_2O$.

The Julianehaab district.

Narssârssuk.

Bøggild: M. o. G. 51, 1915, p. 429.

Gossner und Mussgnug: Centrbl. Min. 1927, A, p. 221.

Only found in crystals which, however, are always very incompletely developed, there being no other form than a prism, the faces of which may be plane and shining, but most frequently strongly striated and also irregular in other ways. The length of the crystals may attain about 2 cm, they may be 5 mm thick, but they may also be fine as hairs. The thickness of the crystals it may for that reason sometimes be difficult to record, as they are frequently composed of a great quantity of thinner hypo-parallel individuals.

The mineral is colourless, either transparent or white and opaque, either on account of the above-mentioned structural conditions or owing to interpositions. Pronounced cleavage along the same prism bounding the crystal. Hardness 6; specific gravity 2.565—2.678. Optically positive, ε is 1.5224, ω 1.5177, the birefringence thus being very small. L. is fusible to an uncommon degree; it is not dissolved by acids. Analysis undertaken by Chr. Christensen: SiO_2 67.55, Al_2O_3 12.69, MnO 0.41, Na_2O 15.47, F 4.93, H_2O 0.77 = 101.82 — O (= F) 2.08 = 99.74. With this corresponds approximately the formula: Na_2Al_2Si/O_{22}, 2NaF. The structural properties are described by Gossner and Mussgnug.

As to the occurrence nothing is known for certain; the entire material which is not particularly large has been collected by Greenlanders and sent to the Mineralogical Museum of Copenhagen together with minerals from N. and it is therefore a priori probable that the minerals originate from there. Among the accompanying minerals there are none of the rare minerals, which are particularly characteristic of the occurrence; only felspar, ægirine, polylithionite and calcite were found, all of them also occurring in the Kangerdluarssuk-area; the felspar, however, is a microcline of a structure formerly described from N. The felspar and the leifite may have grown through each other in the manner of graphic-granite; it is in that case characteristic that the felspar is full of enclosed ægirine needles, whereas the leifite is entirely free from these needles.

The mineral has been named after Leif "the lucky", the discoverer of America, who had his home in the region round Narssârssuk.

203. Sodalite. $Na_8[Cl_2(AlSiO_4)_6]$.

The Frederikshaab district.

Arsuk Ø (Ussing 1908). Slightly south of Moffy's harbour in fissures in an eruptive rock on the southern side of the island millimetre-thick layers of a very strong blue s. were found.

Grønnedal. In nepheline-syenite there has from of old been found imbedded areas of s. of a very strong blue colour; a few crystal individuals attain up to 2 cm in diameter. Like the mineral from the preceding occurrence this s. quickly becomes colourless when faintly heated; it gives no luminiscence in ultra-violet light.

Tuapatsiait (Holst 1880).

Törnebohm: Geol. Fören. Förh. Stockholm, 6, 1883, p. 696.

Found as small colourless grains in syenite.

The Julianehaab district.

Igaliko.

Ussing: M. o. G. 14, 1898, p. 132.

From here originates a single specimen of coarse-grained s. to be present together with microcline in the Mineralogical Museum of Copenhagen; it has a rather faint blue colour, which disappears when heated; faintly shining in ultra-violet light.

The region of Kangerdluarssuk (Giesecke 28-8-1806).

Thomson: Trans. R. Soc. Edinb. 6, 1812, p. 387. — Nickolson's Journ. 29, 1811, p. 285. — Gilbert's Ann. 40, 1812, p. 98. — Journ. des Mines 30, 1811, p. 134.

Allan: Thomson's Ann. Phil. 1, 1813, p. 104.

Van-Mons: Kastner's Archiv f. d. ges. Naturlehre, 3, 1824, p. 82.

Rammelsberg: Pogg. Ann. 109, 1860, p. 76.

Steenstrup: M. o. G. 2, 1881, p. 35.

Lorenzen: M. o. G. 2, 1881, p. 57.

Lorenzen: M. o. G. 7, 1883, p. 10.

Ussing: M. o. G. 14, 1898, p. 127.

Ussing: M. o. G. 38, 1912, p. 144.

Sodalite is found in very large quantities in the rock, which Steenstrup called sodalite-syenite and Ussing naujaite, which constitutes a very large part of the Ilimaussaq batholite; there is the peculiarity about its structure that the other constituents such as microcline, nepheline, ægirine, arfvedsonite, eudialyte and other minerals, are frequently found in very large individuals, entirely interlarded with crystals of s. The latter have a size of about 5 mm and a crystal form which is as a rule fairly developed in the shape of a dodecahedron. S. is however also found in smaller quantities and without crystal form in other of the nepheline-syenites in this area. A few varieties of the naujaite, that is the one occurring at Nunasarnaq, almost entirely consists of s. and must rather be termed sodalitite; in the pegmatite veins s. occurs in far larger individuals (up to about 1 dm) and nearly always of an irregular shape.

S. is as a rule rather fresh, transparent or semi-transparent with vitreous lustre on the cleavage planes and greasy lustre on the fractures; under the microscope it is entirely isotropic. The colour is somewhat varying, most frequently bluish-green owing to the innumerable small interpositions of ægirine and arfvedsonite. But these colours are only attained when the mineral has been exposed to the light; in a freshly broken fragment there is a deep blood-red colour which in sunshine only lasts for a couple of seconds, in ordinary daylight for a few minutes, and in darkness for an illimitable period. Only a couple of times differing varieties of colours have been found; a single sample without specified locality, but otherwise with the usual combination of minerals, has a main mass consisting of s. of the usual greyish colour, and only a smaller part (about 1 cm) has a fine rose-colour, which is durable when exposed to the light. In a locality called Tunuarmiut STEENSTRUP has from of old collected samples, which besides s. of the usual kind contain this mineral in a light-bluish colour. The latter gives no luminescence in the ultra-violet light, whereas all other s. from the area, if sufficiently fresh, yields a strong yellow light.

A peculiar appearance is presented by a sample of s. collected by NYEBOE in 1915; the occurrence is reported to have been found on the northern side of Tunugdliarfik, and it is undoubtedly Tugtup Agtakôrfia whose minerals are distinguished by a very pronounced freshness and purity. S. is found in granular albite in the form of rather large individuals, quite pure and clear of a light-yellow colour; the luminiscence is extremely strong.

According to LORENZEN the specific gravity is 2.31. Analyses have been undertaken by THOMSON (1), EKEBERG (2, in ALLAN) and LORENZEN (3).

	1	2	3
SiO_2	38.52	36.00	36.50
Al_2O_3	27.48	32.00	31.53
Fe_2O.....	1.00	0.25	0.19
CaO	2.70	—	0.25
Na_2O	23.50	25.00	26.30
K_2O	—	—	0.18
Cl	3.00	6.75	7.30
Loss at ign...	2.10	—	—
	98.30	100.00	102.25
$\div$ O (= Cl_2)	0.68	1.53	1.65
	97.62	98.47	100.60

S. was first found by GIESECKE, who mentions it as "ein grünes leicht verwitterndes, granatförmig krystallisiertes Fossil". The first description and analysis was given by THOMSON who gave it the name

it now bears because of its large contents of sodium. The most complete investigations have been undertaken by LORENZEN and USSING.

S. can also be found as an alteration product of nepheline, as to which see this mineral; it undergoes various alterations.

1. To analcite. This alteration, which plays a rather secondary part, begins at the boundary plans of the grains and in fissures in the latter, and from there they penetrate the entire mineral; from each individual of s. a single or a few individuals of analcite are formed.



Fig. 78. Impressions of crystal skeletons (of sodalite?) in felspar. Kangerdluarssuk. 1:1.

2. To "Spreustein". Throughout the rock s. is frequently altered to a red aggregate, which in the main consists of natrolite, but also contains hydronephelite, analcite and probably diaspore. Further details will be mentioned under natrolite.

In this context should also be mentioned some characteristic and beautiful impressions of crystal skeletons, found in the pegmatite veins, which penetrate the various principal materials. Most of these samples have been collected by STEENSTRUP, who on the labels has sometimes written "imprints of ægirine crystals". This is, however, not possible, partly because the form of the skeletons does not at all agree with ægirine, and partly because they may also be found in the larger ægirine individuals. The skeletons (fig. 78) are rather large (up to about 1 dm) and regularly plume-shaped with a thickness of the individual trunks and branches of about 1—2 mm, the distance between the side branches being of the same dimensions. The cross-section of the branches is

irregularly rounded. The branches form an angle of about 70° with the trunk which angle corresponds with the plane angle of the dodecahedron, whereas the angle, which two adjoining plumes form with each other, is about 60°, viz. corresponding with the angle between two dodecahedron faces. The crystals are thus very pronouncedly built up according to this form, and it is the most likely supposition that they are impressions from sodalite crystal skeletons. One circumstance must, however, be emphasized, which makes this less probable, viz. that no trace of s. has ever been found in those skeletons, although this mineral is very easily identificable, even in small quantities, by means of the photoluminiscence, whereas it is at the same time possible to find great quantities of this mineral in a fresh state elsewhere in the same samples.

204. Scapolite. $\begin{cases} Na_8[(Cl_2,SO_4,CO_3,(OH)_2)(AlSi_3O_8)_6] \\ Ca_8[(Cl_2,SO_4,CO_3,(OH)_2)_2(Al_2Si_2O_8)_6] \end{cases}$

An examination of the indices of refraction of the Greenlandic scapolites has proved that they have not exactly the same composition. Of the eight occurrences from which material is at hand, the four (Marmorilik, Niaqornat, Akugdlît and Eqalugssuit) have their ω below the refraction of aniline (1.58), and therefore it must be assumed that the marialitic constituent predominates, whereas the ω of the four other occurrences (Claushavn, Augpalartôq, Maligissaq qava and Gneiss Canon) nearly equals the named value, the meionitic constituent consequently predominating.

The Umanak district.

Marmorilik (Noe-Nygaard 1939). Some of the marble samples brought home contained small (dimensions until 8×2 mm) crystals of s. together with talc a. o. minerals. Form (100) and (110) equally developed, no terminal faces; the colour white.

Akia on Storø (Giesecke 24-4-1811). Is reported to have been found together with quartz, apatite and tourmaline in veins in gneiss and mica-schist.

Niaqornat (Rink).

Rink: Gr. I, 2, p. 212.

Found in a loose block on the mountain of Kangeq in the form of small crystals (up to 15 mm long). The block consists of dolomite, which also contains a great number of very small grains of a black mineral, which into the very thinnest splinters is transparent with a red colour and isotropic, perhaps franklinite. On the scapolite very imperfectly developed faces of (100) and (110) were found. The crystals are transparent, colourless or faintly yellowish; the specific gravity 2.632.

The Christianshaab district.

Claushavn (Rink). Crystallized in fine-grained grey dolomite together with diopside and actinolite. The crystals up to 6 cm long

and 5 mm thick. The combination (100) and (110) of which the one is always very narrow or lacking; no terminal faces; the faces rough and uneven. The colour black, which is due to a great quantity of microscopical black interpositions. Specific gravity 2.643.

Sagdleq (GIESECKE 5-9-1812). Is reported to have been found in a vein of mica-schist together with hornblende, diopside and a little calcite.

The Egedesminde district.

Manitsôq (GIESECKE 19-8-1812). Is reported to have been found in a vein in mica-schist; the central part of the vein consists of scapolite together with diopside and actinolite; the outer parts are limestone with tremolite.

Akugdlît (GIESECKE 1812). Granular mass, nearly without other minerals. In cavities crystals, up to 6 cm in length, bounded by (100) and (110) with rather well-developed faces. The colour grey.

Augpalârtoq (GIESECKE 18-8-1812). Is reported to have been found as imperfectly crystallized columnae in actinolite, and also as tetragonal prisms, together with epidote and calcite.

Inugsulik (SKRAM 1872). Crystallized in a grey schist; elongated crystals (length up to 6 cm, thickness up to 5 mm) bounded by the prisms (100) and (110) which may be well developed; no terminal faces. The colour is black and this is due to the fact that large parts are interlarded with great quantities of impurities; in between those there are, however, quite clear areas.

Between Eqalugssuit and Nordre Strömfjord (FÆSTER 1938). Granular mass of a greyish colour, containing a great number of titanite grains. S. occurs partly in rather large grains, but in between them there are zones with grains 0.1—0.2 mm in size. The colour light-greyish.

The Holsteinsborg district.

Sydbay (GIESECKE 3-5-1807). Is reported to have been found together with garnet in granite.

Maligissap qava (NYEBOE 1915). A mass consisting of scapolite, titanite, actinolite and calcite. S. is found in up to 4 cm long and 2 cm broad individuals, which in several places are bounded by crystal faces; of most frequent occurrence (110) and (111), sometimes also (100), (120), (011) and (001). The faces are generally quite dull, but may be well-developed on some of the smaller crystals. The colour greyish.

The Sukkertoppen district.

Sukkertoppen (GIESECKE 13-7-1808). Mentioned together with hornblende and magnetite as layers in granite.

The Godthaab district.

New Herrnhut (GIESECKE).
GIESECKE: Catalogue of Minerals, p. 213.
Reported to have been found in granite at the ships' harbour.

Hjortetakken (GIESECKE, September 1808). Reported to have been found in a massive form together with tremolite, as layers in granite.

Igdlordluit (GIESECKE 31-5-1810). Mentioned together with apatite and ilmenite in felspar veins in granite.

Narssaq (GIESECKE 15-9-1808). From here prismatic crystals are mentioned in a vein in granite, together with epidote, garnet, diopside, quartz and calcite.

The Frederikshaab district.

Frederikshaab (GIESECKE 6-6-1806). From here mention is made of pistacio-green s. (arcticite) in granite, together with epidote, garnet, diopside, quartz and calcite.

The Julianehaab district.

Nunarssuit (GIESECKE 2-6-1809).
Mentioned together with crystallized felspar in diabase-porphyrite.

East-Greenland.

The west coast of Liverpool Land (O. NORDENSKJÖLD 1900).
O. NORDENSKJÖLD: M. o. G. 28, 1909, p. 283.
Is reported to occur together with hornblende, pyroxene and biotite as segregations in granular limestone.

Gneiss Canon (ROSENKRANTZ 1926). In layers of granular limestone small (about 1 mm) rounded grains of s. are found together with olivine and orthoclase.

205. Gadolinite. $Y_2Fe[OBeSiO_4]_2$

G. from Greenland is mentioned in several places in GIESECKE's account of his travels, but the mineral in question has everywhere proved to be allanite or fergusonite, for which reason the quotations in question will be found under these minerals. Very characteristic is the remark made by DESCLOIZEAUX (Minéralogie 1, 1862, p. 43) according to which g. is to be found on Disko. As there is hardly any such record in the older literature, it must be based upon a specimen present in some collection or other (probably Paris). As there are extremely small quantities of granite on Disko, and as GIESECKE and RINK, who have collected nearly all the older material from this island, do not mention this mineral or any other resembling it, there is a probability that the record is only due to some error. The only certain locality is:

East-Greenland.

Kumaq on the southern side of Ikeq (EBERLIN 1884). Small crystals (up to 6 mm) in pegmatite, consisting of quartz and felspar.

Only two of the crystals are rather perfectly developed, being somewhat different in habits. The following forms were found: (100), (010), (001), (120), (110), (012), (011), (021), (111), ($\bar{1}11$) and ($\bar{1}21$). The other crystals have very few faces, but are otherwise irregularly bounded. The colour black; in thin splinters brownish, birefringent without pleochroism. Specific gravity 4.22.

206. Ussingite. $Na_2[OHAlSi_3O_8]$.

The Julianehaab district.

Kangerdluarssuk.

Bøggild: M. o. G. 51, 1914, p. 105.

U. has been found in three loose blocks consisting of a more or less fine-grained aggregate; crystal bounding is never found, but there are three cleavage directions of which one is distinct, the other two very faint; they are established as (001), (110) and ($1\bar{1}0$) respectively. The crystals are triclinic and pseudomonoclinic, and it would hardly have been possible to determine their triclinic symmetry, if they had not been penetrated by numerous twin lamellae with a twin plane (010). The colour violet-red, varying from nearly white to quite dark. Specific gravity 2.495; hardness 6—7; the indices of refraction $\alpha = 1.5037$, $\beta = 1.5082$, $\gamma = 1.5454$. This yields $2E = 60°34'$ (observed 54°30′—62°40′). Obliquity of extinction on (001) with the twin lamella is 5—6°. Analysis undertaken by Chr. Christensen: SiO_2 58.74, Al_2O_3 17.73, Na_2O 19.91, H_2O 4.19 = 100.57 which fairly agrees with the formula $HNa_2Al(SiO_3)_3$. U. melts easily and is easily dissolved by acids.

U. is found in a nepheline-syenite-pegmatite, rather normal in kind; it also occurs in graphic-granitic intergrowth with microcline. It has further been found in a number of places in Russian Lappland.

207. Hydronephelite. $HNa_2Al_3Si_3O_{12}+3H_2O$.

The Julianehaab district.

The region of Kangerdluarssuk.

Ussing: M. o. G. 14, 1898, pp. 120 and 141.

Bøggild: M. o. G. 26, 1904, p. 101.

Found in the sodalite-syenite as an alteration product of other minerals. According to Ussing it more particularly occurs in the shape of pseudomorphs after nepheline, which farthest out is fibrous with the fibres rectangular on the margin, whereas farther in it seems to be irregularly granular, but on closer investigation it proved as a rule to consist of bundles or bunches of fine fibres. In addition to h. these pseudomorphs also contain arfvedsonite and ægirine. H. also occurs, but in

smaller quantities in pseudomorphs after sodalite. Bøggild mentions h. as a constituent of the erikite crystals from Nunarssuatsiaq; they fill out the very small cavities in the main mass of the erikite.

208. Natrolite. $Na_2[Al_2Si_3O_{10}].2H_2O$.

The Umanak district.

Naqerdlok on Ubekendt Eiland (Giesecke 27-5-1811). Crystallized together with analcite and calcite in the form of columnae up to 3 cm in length and about 1 mm in width, placed at random in all directions. Greyish, semi-transparent.

Tuapagsuit, Qaersuarssuk, Ujaragtôrssuaq and Ikorfat. As to n. in parallel intergrowth with thomsonite see this mineral.

Marrait (Rink).

Rink: Ngr. p. 59.

Irregularly arranged crystals very much resembling those from Naqerdlok. The majority of them are very much thinner.

The Ritenbenk district.

Tuapaussat at Atâ (Rosenkrantz 1938). From the basalt breccia fragments consisting of white crusts of the coalesced minerals, thomsonite and natrolite. Into the cavity projects a dense coating of thin hair-like natrolite crystals.

Sarfarssuk. Irregularly fibrous masses consisting of nearly pure, fibrous natrolite.

The Godhavn district.

Ivnarssuit (Steenstrup 1898).

Bøggild: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1922, p. 40.

Radiating groups of hair-fine crystal needles found on thomsonite crystals in a cavity; within the natrolite in its turn apophyllite, the crystals of which are entirely penetrated by the natrolite needles. No distinct crystal faces. From the same occurrence also very regular intergrowths of n. with thomsonite.

Lyngmarksfjeld.

Bøggild: l. c. p. 37.

In addition to small radiating groups of natrolite a regular intergrowth of n. and mesolite has been found in this place, the mesolite crystal forming the immediate continuation of a natrolite crystal and, furthermore, enclosed in a thin crust of this mineral.

Akiarut (Giesecke). The occurrence and the succession of minerals are mentioned under the apophyllite (p. 316). This is the finest example

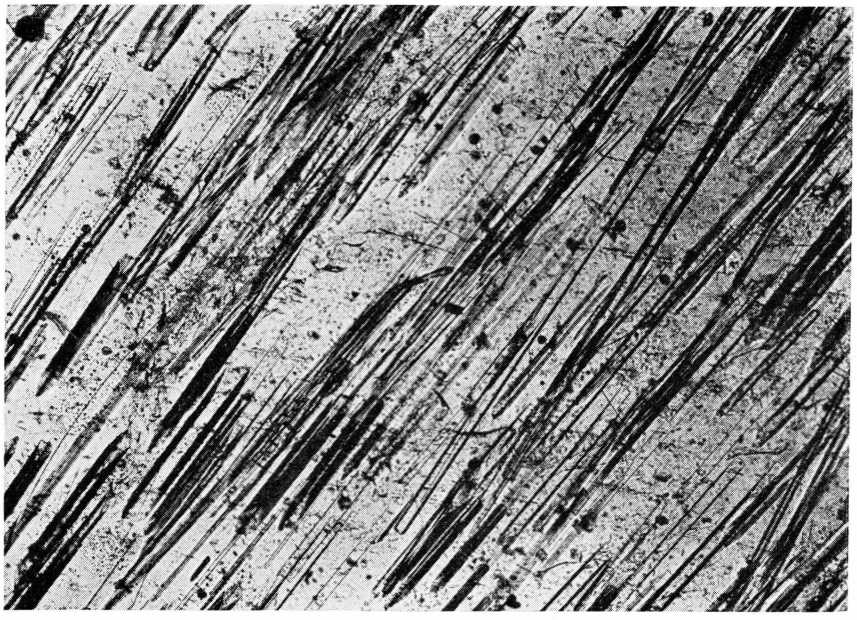


Fig. 79. Natrolite and mesolite in apophyllite. C. 50:1.

of the phenomenon mentioned above, viz. that the natrolite continues its growth as mesolite and then again, after a while, goes back to natrolite. The figures 79 and 80, both in the same place of the preparation, show that phenomenon distinctly. The figure 79 shows a lot of needles as seen in common light, whereas fig. 80 shows the same area between crossed nicols; we see that all the needles in a certain area get almost quite invisible, the double refracting needles being the natrolite and the invisible parts mesolite, which has an exceedingly small double refraction. The needles are placed in apophyllite which has also a very weak double refraction. It is obvious that the two minerals, natrolite and mesolite, cannot form homogeneous mixtures, so that a small alteration in the composition of the solution is sufficient to explain the formation of one or the other of the two minerals.

The Julianehaab district.

Narssârssuk (Flink 1897, Ødum 1926).

Flink: M. o. G. 14, 1898, p. 232.

Flink: M. o. G. 24, 1901, p. 107.

Only found in small quantities; Flink's material consists of thin crusts on analcite; from the latter closely packed crystals issue, being up to 2 mm in length and bounded by (110), (100), (010) and (111). The faces dull; the interior of the crystals clear and transparent,

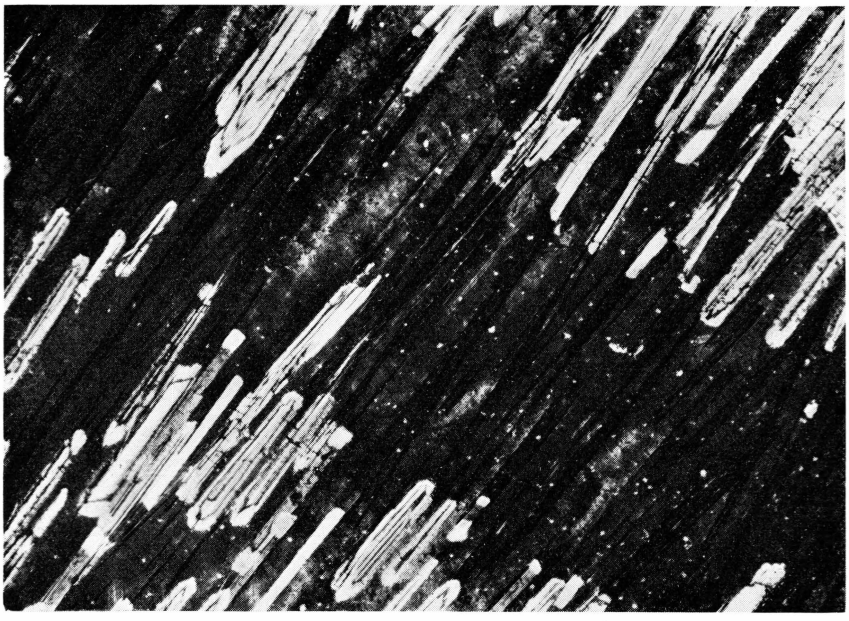


Fig. 80. Same as fig. 79. Nic. +.

the outside enamel-like, white, consisting of fibrous aggregates with the fibres normal to the faces. ØDUM's material is a coarse-grained aggregate (size of grains about 1 cm) unaccompanied by other minerals.

The region of Kangerdluarssuk.
KOBELL: Jour. f. prakt. Chemie, 1, 1838, p. 3.
RAMMELSBERG: Pogg. Ann. 90, 1860, p. 577.
LORENZEN: M. o. G. 2, 1881, p. 60.
LORENZEN: M. o. G. 7, 1893, p. 10.
USSING: M. o. G. 14, 1898, pp. 121 and 137.
FLINK: M. o. G. 14, 1898, pp. 240, 245, 248, 253, 258.

Found in very large quantities in the pegmatite veins of the nepheline-syenite, partly as crystals in cavities, and partly as a primary constituent of the pegmatite; further, the mineral very often appears as pseudomorphs after other minerals. The crystals vary in size from 1 dm to 1 mm; the form is very different, the crystals now being long, prismatic with the usual faces (100), (010), (110), (111), now more isodiametrical, and finally they are often, and this is rarer in the mineral, flat pyramids (111) with the faces of the prism zone very narrow or entirely lacking. Many of the smaller crystals are clear and transparent with shining faces; larger crystals, on the other hand, are whitish, greyish, greenish or bluish, semi-transparent with uneven, frequently quite rounded faces. The crystals mentioned by FLINK (p. 248) from

Tuperssuatsiaq, which look like small scapolite crystals, I have not been able to find.

As a constituent of the pegmatite n. sometimes occurs in very great dimensions, for instance, it is possible to find cleavage fragments of up to 4 by 3 by 3 cm, clear and transparent of a greenish colour. A more peculiar form has been found in the two neighbouring localities, Tugtup Agtakôrfia and Igdlúnguaq; it is here white and opaque and rather looks like chalk. Under the microscope the single grains, the size of which is less than 0.02 mm prove to consist of a radiating aggregate of fine needles. In this mass several of the minerals characteristic of the pegmatite are enclosed, such as sodalite, sphalerite, steenstrupine and epistolite.

N. may occur as pseudomorphs after nepheline and sodalite; they have been subjected to special investigations by Lorenzen and Ussing. The former pseudomorphs have only been found in a single case; n. forms a rather coarse - grained clear and colourless aggregate; sometimes the middle part of the pseudomorph has been altered into a mass resembling flour, into which crystals of n. project.

Pseudomorphs after sodalite, the so-called "Spreustein", are extremely common, and in many cases they give the rock a reddish tinge, even when seen at a long distance. They generally form microcrystalline masses, which have the usual form of the sodalite with sharp boundaries towards eudialyte and arfvedsonite, whereas the boundaries towards felspar and nepheline are obscured, as these minerals may also in part be altered into n. Together with n. analcite, hydronephelite and diaspore may occur. In other cases n. in the pseudomorphs is coarsely radiating; the outer form is irregular, and it is in the main only possible to conclude anything as to the nature of the pseudomorph by the fact that there are transitions to the ordinary type.

Analyses of n. have been undertaken by Kobell (1) according to the description probably "Spreustein"), Rammelsberg (2, judging by the composition a very impure pseudomorph, probably a mixture of n. and hydronephelite) and Lorenzen (Spreustein, 3 of the former, 4 of the latter type).

	1	2	3	4
SiO_2	46.94	43.20	46.54	47.07
Al_2O_3	27.00	32.54	27.16	27.02
FeO	—	—	1.17	0.58
CaO	1.80	3.00	0.89	0.11
Na_2O	14.70	11.42	15.52	16.05
K_2O	—	—	—	tr.
Cl	—	tr.	tr.	—
H_2O	9.60	9.84	9.65	9.56
	100.04	100.00	100.93	100.39

East-Greenland.

Henry Bjerg, Turner Ø and Kap Brewster (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 112.

Rather insignificant occurrences mostly in the form of radiating masses.

209. Mesolite. $Na_2Ca_2[Al_2Si_3O_{10}]_3$.

The Umanak district.

Svartenhuk (Rosenkrantz 1947). In the large valley between Umivîk and Umiarfik was collected a specimen consisting of a geode without surrounding rock; a single radiating mass of m. of a diameter of c. 2 cm, from which a lot of very fine needles protrude through calcite which fills the whole remainder of the space; the colour of both minerals is pure white.

Kangilia (Skou 1946). A geode consisting of a single radiating mass, built up of exceedingly fine needles; the refraction is the normal one for the mineral, no double refraction visible. The colour pure white.

The Godhavn district.

Lyngmarksfjeld. As to m. intergrown with natrolite see this mineral.

Akiarut (Giesecke 14-5-1812). From here there are a great number of samples of a peculiar mass, by its specific gravity (about 0.4) reminding of diatome earth, but more continuous. Under the microscope it proved to consist of mere fibres, which are so thin that they are nearly invisible; they are placed irregularly. In ethylbenzoate (n = 1.505) they disappear so completely that it is hardly possible to discover them, and there is therefore a certain likelihood of the mineral being m. which also agrees with the fact that no birefringence is seen. In the same place Giesecke has also collected more ordinary m. in globular aggregates and fine crystals. As to the relation between m. and natrolite see above p. 398.

Ũnartorsuaq (Giesecke 25-8-1810). Together with chabazite and calcite as globular masses and fine crystals.

Tarajungitsoq (Giesecke 1-8-1812). Fine crystals coating the walls in cavities together with apophyllite.

Qarusuit (Rink). Found as small hair-shaped crystals together with chabazite.

Eqalunguit and Erqua (Porsild 1915). Between chabazite crystals there is a peculiar mass, which in consistency and appearance

rather resembles flour or starch, being snow-white, completely homogeneous and rather soft. Under the microscope it proves to consist of very fine and short needles, their optical properties rather agreeing with those of mesolite.

Qarssuanguit - qaqait (GIESECKE 26-7-1812). Hair-fine crystals in cavities between chabazite and analcite.

East-Greenland.

Henry Bjerg (O. NORDENSKJÖLD 1900).

BØGGILD: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1922, p. 38.

Intergrowth of m. with scolecite, so that this mineral forms rather thick, straight needles, between which there is a very fine and silky m.

Turner Ø (O. NORDENSKJÖLD 1900).

BØGGILD: M. o. G. 28, 1909, p. 112.

BØGGILD: K. D. Vid. Selsk. etc., p. 39.

Greatly decomposed, brownish, forms a crust 3 mm thick, on which hair-shaped crystals are found. In the same locality also occurs a mixture of the two above-mentioned minerals, the elements however being so fine that they are difficult to distinguish from each other; the entire occurrence looks like a mesolite, where in certain areas there is a negative sign in the longitudinal direction, for which reason it is to be supposed that scolecite has been intermixed with it. From the same locality there is also a sample of "positive mesolite", which may be supposed to be m. intermixed with natrolite.

Kap Brewster (O. NORDENSKJÖLD 1900).

BØGGILD: M. o. G. 28, 1909, p. 113.

Radiating groups (about 2 cm) together with calcite, with hair-fine crystals projecting into them.

Steensby's Bjerg and Clavering Ø. As to these two localities see what is recorded below about thomsonite.

210. Thomsonite. $NaCa_2[Al_2(Al,Si)Si_2O_{10}]_2 5H_2O$.

As the refraction for this mineral is particularly important from the point of view of determination, there might be reason to call attention to the extreme confusion which seems to prevail on this point. DESCLOIZEAUX (Man. de Min. 1862, p. 374) has for t. the values 1.479, 1.503 and 1.525; HIBSCH (Tschermak's min. petr. Mitt. 34, 1917, p. 197) has the corresponding values 1.521, 1.523, 1.534. LARSEN and BERMAN have three different statements: 1) 1.511, 1.513, 1.518, 2) 1.520, 1.525, 1.540, 3) 1.528, 1.531 and 1.545. GORDON (Proc. Acad. Nat. Sci. Phil. 76, 1924, p. 261) has the values $\alpha = 1.535$, $\beta = 1.531$ (these two values have surely been exchanged for each other) and $\gamma = 1.541$. If all of these values should be correct, the mineral must be able to vary very strongly, and there is

otherwise nothing pointing in this direction. According to my experience HIBSCH's and No. 2 of LARSEN's values are very close the right ones, and in practice it will nearly always be possible to determine the mineral accurately by observing that it disappears almost entirely in chlorbenzene (n = 1.524).

The Upernavik district.

Qivssâq (RINK). Closely packed, semi-spherical masses (up to 5 mm) frequently together with chabazite crystals.

Fastlandet (ɔ: The Continent) (RINK).

RINK: Gr. I. 2, p. 217.

The locality of this occurrence is uncertain; it is possible that it may be the naze of Sukaussat on the peninsula of Kangeq. RINK records various zeolites; small semi-spherical masses together with apophyllite are present at the Mineralogical Museum of Copenhagen.

Svartenhuk (ROSENKRANTZ 1947). 12 km south of the outlet of Simiutaq Kua there was found a sample of the same peculiar form of t. which is described from some of the following localities f. i. Brinkley Bjerg. The spheres are c. 2 mm, their surface is rather plane; the colour is light brown.

The Umanak district.

Tuapagsuit, Qaersuarssuk, Ujaragtôrssuaq and Ikorfat.

BØGGILD: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1922, p. 40.

In these occurrences lying close to one another, an investigation of the older material has been made, with the result that t. is here of quite a special kind, in that it is not as otherwise rather tabular, but occurs in thin needles mixed in a parallel position with needles of natrolite, as a rule in such a manner that the latter are the largest and most regular and also continue farther into the cavity, whereas the thomsonite needles are generally thinner and less regular. However, a series of heavier individuals are as a rule found close to the natrolite needles. That the mineral in question is really t. appears both from the refraction and from the other optical conditions.

Kangilia (ROSENKRANTZ 1946). Here a spherulitic mass was found consisting of spheres with a diameter of c. 2 mm and partly grown together with very uneven free surfaces. The interior of the spheres is in the outer parts white, in the central parts brownish-grey. The microscopical structure is so fine that it is impossible to see other optical properties than the refraction which is very close to 1.524; otherwise we must conclude from the analogy with the very similar mineral from Brinkley Bjerg that the mineral at hand here is thomsonite.

Niaqornârssuk (STEENSTRUP 1881). Inconsiderable spherical masses together with apophyllite; faint traces of tabular crystals on the surface. The colour greyish-white.

Hare Øen (GIESECKE 1811). Small (2 mm) spherical groups of tabular, very flat crystals, without distinct faces; the colour brownish.

The Ritenbenk district.

Atâ (ROSENKRANTZ 1938). From the basalt breccia crust-shaped white masses, for the greater part consisting of a fine-grained t. with irregularly orientated individuals; into that cavity crystals of t. and natrolite project.

Ũnartoq (STEENSTRUP 1898). Regular, spherical aggregates (1 cm). At the surface small, projecting, rather insignificant crystals. The colour greyish-white.

Igdlukúnguaq (PORSILD 1902). In a single loose-lying amygdaloid there were small (about 0.5 mm) crystals with *a*, *b*, *c* and *m*. The crystals often composed of several hypoparallel individuals. Clear and colourless; the faces curved and striated.

The Godhavn district.

Skarvefjeld (STEENSTRUP 1898). The usual spherical masses (about 5 mm) together with natrolite, apophyllite and analcite. The colour whitish silver-shining. Here there are also similar intergrowths of t. with natrolite as those described above, a particularly pronounced phenomenon being that the individual natrolite crystal is surrounded by more distinct and larger thomsonite crystals.

Lyngmarksfjeld.

GAERTNER und MACHATSCHKI: Centrbl. Min. 1927 A, p. 365.

G. and M. have undertaken analyses of t. from this locality, the result being the following (1 attained by G. and 2 by M.).

	1	2
SiO_2	41.55	41.73
Al_2O_3	30.13	29.80
CaO	11.20	11.28
Na_2O	3.43	3.56
K_2O	0.52	0.46
H_2O	13.07	13.21
	99.90	100.04

Lyngmarken (PORSILD 1946). Here some samples were collected of the same pisolitic nature as the mineral described from Kangilia. The spheres are 1—2 mm in diameter; the colour of the t. itself is greyish,

but most of the surfaces are covered with a layer of ferric oxide giving the whole an intensive red colour. As to the optical properties the same may be said which was said about the mineral from Kangilia.

Akiarut. Small semi-spherical masses on which fine needles of mesolite are to be found. It does not appear, whether the minerals are parallely intergrown (cf. also apophyllite p. 316).

Uivfaq. Semi-spherical masses (1 cm) the surface of which is striated by the projecting crystals.

Tarajungitsoq. Small, semi-spherical masses together with chabazite.

Qarssuanguit-qaqait (GIESECKE 1812). Almost like the preceding occurrence.

Anarsuit at Nângissat (GIESECKE). Small spherical groups with traces of lenses on the surface; the colour reddish or brownish.

East-Greenland.

Henry Gletscher (O. NORDENSKJÖLD 1900).

BØGGILD: M. o. G. 28, 1909, p. 110.

Small spherical masses together with levynite and chabazite.

Henry Land (O. NORDENSKJÖLD 1900).

BØGGILD: ibid.

Found in the usual radiating masses; sometimes distinct crystals (up to 2 mm) are found. The most usual combination is *a* (100), *m* (110) and *e* (801); also sometimes *f* (601), *r* (101), *c* (001) and *b* (010); the faces most frequently dull.

Turner Ø (O. NORDENSKJÖLD 1900).

BØGGILD: ibid.

Radiating masses together with scolecite; sometimes quite small crystals are found without distinct faces.

Kap Brewster (O. NORDENSKJÖLD 1900).

BØGGILD: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1922, p. 39.

Here t. is found intergrown with mesolite in radiating groups with quite small crystals of both minerals. In thin sections they most frequently have a parallel position, but the needles of t. may also sometimes extend in all possible directions.

Gaasefjord, eastern side of — (BAY 1891).

BØGGILD: M. o. G. 28, 1909, p. 110.

Found in very large quantities together with chabazite, partly as a thin crust (1 mm) of very small closely packed crystals, and partly as small regular, hemi-spherical aggregates; no distinct crystal form. The colour is brownish.

Steensby's Bjerg on the north coast of Hold with Hope (Sig. Hansen 1929). At a height of 400 m cavities with radiating groups of t. with mesolite have been found on the underside of a large basalt sill; in many cases the fibres of t. are rather irregularly orientated; the groups are up to 2 cm in size, and they are not accompanied by other zeolites than analcite.

Clavering Ø (Sig. Hansen 1929). East of Hird's hunting hut, on the southern side of the island, radiating groups of t. have been found, sometimes intermixed with smaller quantities of mesolite.

Brinkley Bjerg on Clavering Ø (Alex. Jensen 1933). Here a rather large sample was found of a pisolitic thomsonite, similar to that described from Kangilia in the Umanak district and from Lyngmarken in the Godhavn district. It seems that the t. from these three localities form a natural group, the aspect of which rather differs from the mineral from other localities. The whole sample consists of small (2—3 mm) spheres which are partly grown together; the free surfaces are very uneven, of grey colour, the interior of the spheres is of a dark-brown colour, normally not common in the zeolites. The spheres are built up of radiating individuals the form of which is very irregular. Although the mineral from the locality in question is better developed than that from the two named places it has not been possible to determine the optical properties; only the refraction is found to be like the one mentioned above. The specific gravity was found to be 2.24—2.25. An analysis undertaken by A. H. Nielsen gave: SiO_2 39.98, TiO_2 0, Al_2O_3 28.04, Fe_2O_3 1.14, FeO 0, MnO 0, MgO 0.46, CaO 11.66, Na_2O 4.88, K_2O 0, H_2O $\div$ 1.10, H_2O + 12.44, Cr_2O_3 0, BaO 0, SrO 0, CO_2 0, Cl 0, F 0 = 99.70.

211. Scolecite. $Ca[Al_2Si_3O_{10}] \cdot 3H_2O$.

The Umanak district.

Between Igpik and Umivik (Steenstrup 1881). Large radiating groups (up to 7 cm); no crystal faces, the colour white.

Hare Øen (Giesecke 1811). Radiating groups of very small (5 by 0.5 mm) crystals in cavities together with thomsonite and chabazite.

The Godhavn district.

Skarvefjeld (Steenstrup 1872). Small prisms (3 mm) in radiating groups; forms (110) and (111).

Akiarut (Giesecke 14-5-1812). Small prisms (5 mm) radiating groups on stilbite; forms (110) and (111).

Lyngmarksfjeld (Fr. Petersen 1897). Small radiating masses in fissures in basalt together with chabazite; in cavities hair-fine crystals.

Godhavn (Lauge Koch 1913). At the arctic station some samples consisting of radiating masses have been collected from the wall of a cavity; towards the middle free crystals (about 1 mm) project with well-developed faces of (110) and (111).

Tunusua (Lauge Koch 1913). Plates formed as fillings of fissures about 1 cm thick, consisting of very irregularly fibrous or entirely granular s. In a few cavities there are some very small and indistinct crystals.

Røde Elv (ɔ: Red River) at Godhavn (Steenstrup 1898). Small (1—3 mm) hair-fine prisms, very closely packed in cavities, partly arranged in radiating groups. No distinct crystals.

Blaafjeld (Steenstrup 1872). Radiating masses with freely-projecting crystals (at about 2 mm). Forms (110) and (111).

Anguiartoutit (Giesecke 8-9-1811). Found on stilbite crystals in the form of small crystals (10 by 0.5 mm). Forms (110) and (111).

Qarusuit (Steenstrup 1898). Hair-fine crystals (about 5 mm) found in groups on stilbite; no distinct faces. The colour brownish.

Qarssuanguit-qaqait (Giesecke 26-7-1812). Found in radiating masses with freely projecting crystals, which as a rule are rather small (1 by 5 mm) but in a single case attain a quite considerable size (thickness up to 5 mm). On the smaller crystals (110), (111) and (010) are found, on the larger crystals also (101). The crystals are always twins, which for that matter is also the case with those from the other localities. The faces are unusually shining and plane, strangely enough particularly on the larger crystals. Owing to the nature of these faces it was possible to determine the refraction indices by means of a total reflectometer: $\alpha = 1.5122$, $\beta = 1.5186$, $\gamma = 1.5195$ whereof $2V = 36°26'$. Analysis undertaken by Ussing: SiO_2 45.63, Al_2O_3 25.94, CaO 14.12, H_2O 13.92 = 99.61.

Eqalunguakat (Kornerup 1880). Radiating aggregates without developed crystals.

The Julianehaab district.

Kitsigsut Øer (Jessen 1894).
Jessen: M. o. G. 16, 1896, p. 145.
Found in cavities in diabase veins in syenite.

East-Greenland.

Henry Bjerg (O. Nordenskjöld 1900).
Bøggild: M. o. G. 28, 1909, p. 113.

Radiating crystals of up to 6 cm in length; forms (110) and (010). Rather untransparent and decomposed with dull faces.

Turner Ø (O. Nordenskjöld 1900).

Bøggild: ibid.

Radiating masses (up to 5 cm) together with thomsonite; a few crystals were found with (110) and (010).

Sabine Ø (O. Nordenskjöld 1900).

Bøggild: ibid.

A few rounded and decomposed fragments of radiating s.

212. Laumontite. $Ca[AlSi_2O_6]_2 \cdot 4H_2O$.

The Umanak district.

Sermersôq (Giesecke). Crystals (2—8 mm long) on the walls of cavities; calcite crystals found on the l. Combination (110) and (201), but only quite few crystals have preserved the form. The colour white.

East of Marrait (Rosenkrantz 1946). In a breccia of pillow lava is found a rather large specimen (0.6 kg) consisting of l. without other minerals and without any rock. The l. is fine-grained and of a very loose consistency; the colour is white.

The Ritenbenk district.

Sarfârssuit (Giesecke).

Giesecke: "Greenland" in Brewster's "The Edinburgh Encyclopædia", 1916.

Is reported to have been found in small veins, penetrating tuff; in the material at hand there are crystals of up to 1 cm; the form as the preceding one, with rather irregular and curved faces.

The Godhavn district.

Nangissat (Giesecke 1813). Crystals (about 5 mm) unaccompanied by other minerals, excepting some quite small (0.5—1 mm) indistinctly formed calcite crystals. The form the usual one, but faces are only found in quite a few cases, as most of the crystals are greatly disintegrated; the colour reddish.

East-Greenland.

Henry Land (O. Nordenskjöld 1900).

Bøggild: M. o. G. 28, 1909, p. 129.

Forms a kind of cement in a basalt breccia near a hot spring, sometimes together with calcite. In cavities distinct crystals were found (up

to 1 cm) with (110), (001) and (201); a few twins with twin plane (100). The crystals are of a reddish-white colour, strongly disintegrated and in the course of time completely pulverized.

213. Ptilolite (Mordenite). $(Ca,K_2,Na_2)[AlSi_5O_{12}]_2 \cdot 7H_2O$.

In this connection there is no reason to go into details as to the intricate conditions relating to these two minerals, the Greenland-material not being of such a kind as to contribute anything new in this respect. It should a priori not be thought difficult to distinguish between the two minerals, which have the same chemical composition and for that matter nearly the same qualities, in that p. has a parallel extinction and m. an obliquity of extinction of 16°30′. However, by means of röntgenographic investigations WAYMOUTH, THORNLEY and TAYLER (Amer. Mineralogist 23, 1938, p. 540) have proved that m. is also rhombic, the two minerals thus being identical, in which case they ought to be called mordenite, which is the oldest name. As it seems difficult to understand, how rhombic symmetry can be reconciled with the above-mentioned angle of extinction, it is perhaps most correct to await more detailed investigations as to this. The Greenland ptilolites are rather homegeneous, very finely fibred; the individual fibres have a parallel extinction, are faintly birefringent, negative. The refraction the same or a little less than that of ricinusoil.

The Ritenbenk district.

Nungerut.

BØGGILD: K. D. Vid. Selsk. Mat.-fys. Medd. IV, 8, 1922, p. 23.

From here we have a rather large geode which on the outside is coated with an about 5 mm thick layer of p., whereas the whole of the interior is filled with stilbite. The most peculiar feature of this occurrence is that at least in some places there is a layer of a grey-brown colour consisting of p., closely interlarded with spherulites; the latter may be of a rather regular spherical form, but are also frequently composed of several spheres; the size of the individual spheres may attain about 0.2 mm. The colour is brownish or greenish-grey in transmitted light. The structure is irregularly radiating; the refraction is about 1.58; strong, positive birefringence. When it is treated with acids iron is very easily washed out, and as a remainder the spherulite consisting of amorphous silica is obtained. This makes one think of hisingerite, and it is possible that we are dealing with the mineral canbyite, described by HAWKINS and SHANNON (Amer. Min. 9, 1924, p. 1); canbyite is regarded as a crystalline form of hisingerite, and in all respects agrees well with the mineral in question. Any certain proof it will hardly be possible to provide, as owing to the intimate intergrowth with the ptilolite it is difficult to supply material which can be used for a chemical analysis.

The Godhavn district.

Skandsen.

Bøggild: l. c.

Here a very large (about 2 dm) geode has been found; nearly the whole of the interior is filled with p. which forms a soft felt-like mass of extremely fine fibres. In the latter there are partly heulandite crystals, partly a larger continuous mass of granular apophyllite.

Kuanit (Nygaard 1909).

Bøggild: l. c.

From this locality originates a large geode in loose sandstone. P. which practically fills the entire space is in some places of the usual loose, felt-like quality, but in large areas, more particularly in the outer parts, it is very hard; this hardness is owing to a large quantity of chalcedony spheres, which are scattered about them, and which in some localities are concentrated into larger continuous masses. The chalcedony is penetrated by masses of fibres of p. orientated in all possible directions.

East-Greenland.

Gaasefjord (Bay 1891).

Bøggild: l. c.

Numerous geodes in basalt filled with p. of the common appearance.

214. Ashcroftine. $KNa(Ca,Mg,Mn)[Al_4Si_5O_{18}] \cdot 8H_2O$.

The Julianehaab district.

Narssârssuk (Gordon 1923).

Gordon: Proc. Acad. Nat. Sci. Phil. 76, 1924, p. 261.

Hay and Bannister: Min. Mag. 23, 1933, p. 305.

Crystallizes tetragonally, but developed crystals are not found, only fibrous aggregates, strong cleavage parallel with a prism, faint along the base. Hardness 5; specific gravity 2.61. Optically positive; $\varepsilon = 1.545$, $\omega = 1.536$. Analysis undertaken by Whitfield (in Gordon): SiO_2 38.09, Al_2O_3 26.61, Fe_2O_3 trace, MnO 0.79, CaO 5.72, MgO 0.87, Na_2O 3.62, K_2O 5.65, H_2O above 100° 12.00, H_2O at 100° 6.40 = 99.75. When setting apart H_2O at 100° the formula is KNa (Ca, Mg, Mn) $[Al_4 Si_5O_{18}] \cdot 8H_2O$.

As mentioned above the mineral is found in rosy, fibrous aggregates; the length of the individual fibres hardly exceeds 4 mm; the thickness is about 0.25 mm. The mineral was found in a single vug up to 15 cm in diameter, bounded by typical augite-syenite. A coarse aggregate of ægirine and felspar formed the floor of the vug with a minor amount of polylithionite and graphite. Deposited on it were quartz, fluorite,

elpidite and rather large crystals of epididymite. Afterwards were formed small crystals of calcite, followed by the precipitation of the ashcroftine.

GORDON regarded the mineral as rhombic and called it kalithomsonite, seeing that habitually it greatly resembled thomsonite. By means of röntgenographic investigations HAY and BANNISTER proved that the mineral was tetragonal and had no closer relationship to thomsonite, for which reason they gave it a new name and called it after an English mineralogist.

215. Heulandite. $Ca[Al_2Si_6O_{16}] \cdot 5H_2O$.

The combination (001), (201), ($\bar{2}$01), (110) and (010) is so prevailing in this material that the form will only be mentioned in the following, when in some way or other it differs from the usual one.

The Umanak district.

Kugssininguaq (ROSENKRANTZ 1938). In a basalt tuff a fragment of fossillized wood was found with only a very faintly preserved wood structure. The greater part of the mass consisted of a very fine-grained and very impure h. without any crystal form; a smaller part consisted of fine-grained calcite.

The Ritenbenk district.

Nungerut (RAVN 1909). Small crystals in basalt together with stilbite and chabazite.

The Godhavn district.

Skandsen (PORSILD 1902). A few small crystals scattered in ptilolite.

Puilasoq (RINK). Crystallized together with calcite in clear crystals with very shining faces.

Igpik (O. R. B. HANSEN 1937). Small crystals together with analcite.

Karartut (GIESECKE).

HINTZE: Hbd. d. Min. 2, 1897, p. 1758.

Is reported to have been found as water-clear, foliated masses in basalt tuff.

Akiarut (GIESECKE 1812). Small (about 5 mm) crystals with stilbite; water-clear with shining faces.

Unartorssuaq (GIESECKE 1812). Crystallized (about 1 mm) in a cavity together with chabazite and stilbite; the colour brownish or reddish.

Unartoq (STEENSTRUP 1872). Greatly resembling the preceding occurrence, the faces irregular and striated.

Tarajungitsoq (GIESECKE 1813). Small (about 0.5 mm) crystals in cavities in basalt tuff; on them larger crystals of stilbite; the colour brownish.

Orpît Qâqât (SOLE MUNCK 1939). Crystallized in cavities together with dark-brown, columnar calcite. The crystals (about 1 cm) mostly rather imperfectly developed.

Nângissat (GIESECKE 1813). In all essentials like Tarajungitsoq.

Iginiarfik (STEENSTRUP 1898).

STEENSTRUP: M. o. G. 24, 1901, p. 285.

Found together with several other zeolites in a red, tuff-like amygdaloid; the size 5—8 mm. Semi-transparent, reddish-grey.

East-Greenland.

Iluileq (EBERLIN).

BØGGILD: M. o. G. 28, 1909, p. 122.

In the drift-ice blocks of basalt were found, in the cavities of which by far the prevailing mineral was h., which is not dominating in the East-Greenland basalt, neither does the rock resemble any of those known from East-Greenland; it is hardly possible to conclude anything as to where the blocks came from. The crystals are of different forms, and some of them are rather rich in faces with (021) besides the usual ones. The crystals on an average small.

Kap Adelaer (EBERLIN 1884). Small (1—2 mm) crystals together with calcite, garnet, epidote and quartz; clear and transparent with shining faces.

Henry Gletscher (O. NORDENSKJÖLD 1900).

BØGGILD: l. c. p. 120.

Crystals (3—6 mm) in cavities in dolerite. Form like a quadrangular prism, the faces (010) and (001) prevailing. Very small crystals (about 0.5 mm) were found in a breccia together with chabazite. Tabular parallel with (010) and with a face (501) which is otherwise not known in this mineral.

Henry Bjerg, eastern side of — (O. NORDENSKJÖLD 1900).

BØGGILD: l. c. p. 121.

Small red crystals (about 2 mm) in cavities, in basalt.

Kap Brewster (O. NORDENSKJÖLD 1900).

BØGGILD: l. c.

Small crystals either accompanied by stilbite or without other

zeolites, but sometimes with calcite. The former are flat tables, reddish, the latter are semi-transparent, greyish.

Gaaseland (Bay 1891).
Bøggild: l. c. p. 122.
Small clear crystals (2—3 mm) together with chabazite.

216. Stilbite. $Ca[Al_2Si_7O_{18}] \cdot 7H_2O$.

The Thule district.

Between Kap York and Kap Alexander (Mylius-Erichsen 1903—04). S. occurs as a coating on the walls in numerous closely packed and partly convergent cavities; the rock between the cavities, which is found in very small quantities, is very fine-grained, probably a tuff. The length of the crystals about 5 mm; the faces very imperfectly developed.

The Umanak district.

Tuapagssuit (Steenstrup 1872). Small (2—3 mm) crystals in cavities in basalt. The shape quadrangular-prismatic (001), (010), ($\bar{1}$01) with very small faces of (110). Colourless, transparent.

Tunorssuaq (Sole Munck 1946). Upon the crest of the mountain at a height of 800 m, among other loose samples, a fragment was found of a geode with rather long (up to 4 cm) and thin (c. 4 mm) crystals; the faces very imperfectly developed; the colour white.

Natdluarssuk (Steenstrup 1872). Whitish, radiating; in cavities crystals with (010), (011), (010) and (110); the faces very irregular.

Nûluk (Rink). Radiating, white masses in a fissure in basalt; no distinct crystals.

Hare Øen (Giesecke 1811). Small crystals (about 2 mm) together with apophyllite; form (001), (010) and ($\bar{1}$01) with regularly developed faces. Semi-transparent, greyish or brownish.

The Ritenbenk district.

Kûgánguaq (Noe-Nygaard 1939). A boulder consisting of a fine-grained stilbite. The colour vividly red, interchanging with lighter and darker tinges; the colour is owing to a great quantity of small enclosed bodies.

Ujaragssuit (Steenstrup 1898). Small (2—5 mm) crystals together with chabazite; (001), (010), (110) with smaller faces of (011) and ($\bar{1}$01). The crystals irregularly constructed with curved faces. Dim, greyish.

Ũnartoq (Steenstrup 1898). Crystals (5—10 mm) without other minerals. Form (010), (001), (110), ($\bar{1}$01) with secondary (011) most of the crystals sheaf-like. The colour whitish-grey.

The Godhavn district.

Ivnarssuit and Karartut (Giesecke 30-9-1809; Porsild 1915). From Giesecke some small crystals (about 5 mm) originate, found together with apophyllite and chabazite; the form elongated prismatic, (010), (001), (110), ($\bar{1}$01); the crystals partly sheaf-like greyish, semi-transparent. The material originating from Porsild is a tuff-like mass, consisting of white grains (dimensions from 1 mm to several cm) of an irregular form, found in a red ground-mass. The latter consists of numerous small (about 1 mm) crystals of stilbite, which are rather loosely connected with a strongly birefringent substance, probably an iron oxide. The white grains consist of a very fine-grained isotropic mass of refraction about 1.48; when heated it reacts like a zeolite, and it is hardly possible to determine it in detail. In it are found a number of stilbite crystals of the same size as those in the red substance.

Lyngmarken (Rink). Together with chabazite in cavities in basalt; most of the crystals are rather large, sheaf-shaped, whitish; a few less prismatic with the usual faces.

Lyngmarksfjeld (O. R. B. Hansen 1937). Large up to 3 cm broad groups of crystals in the shape of spherical sectors; on the outside only bounded by the base-like face (101); together with s. small heulandite crystals are found.

Akiarut (Giesecke 1812). Greatly resembles the fragments from the preceding locality.

Røde Elv (Porsild 1926). Very nearly like the preceding occurrences.

Ũnartorssuaq (Giesecke 1-6-1812). Here mention is made of "Stilbit in zum Theile hohlen und von der Steinart rothgefärbten Afterkrystallen"; but in the lumps present at the Mineralogical Museum of Copenhagen there is nothing corresponding with this description; s. is found in crystals (10 mm) of the usual form, somewhat sheaf-shaped.

Tuapagsuit (Steenstrup 1872). Small, inconsiderable crystals, with the tendency so common in this region, to form radiating groups, outwardly bounded by ($\bar{1}$01) so that almost continuous fragments of spherical faces may be found on the outer side of the groups.

Blaafjeld (Uivfaq?) (Steenstrup 1872). Small (2—10 mm) crystals with chabazite, partly sheaf-shaped; the terminal faces ($\bar{1}$01) and (110).

Ũnartoq (Steenstrup). In most respects like the preceding occurrence.

Anguiartoutit (Giesecke 8-9-1811). Flat, partly sheaf-like crystals (up to 25 mm long) with scolecite. Brownish-white, untransparent.

Kuanerssuit (Giesecke 1807). Small, rather regular, tabular, reddish crystals.

At Kuanerssuit, in the interior of the valley Me Mouritzen (1946) collected a sample essentially consisting of a single crystal perfectly developed with a regular sheaf-form; the length is 6 cm (fig. 81). The sample also contains parts of other similar crystals; the colour is white.

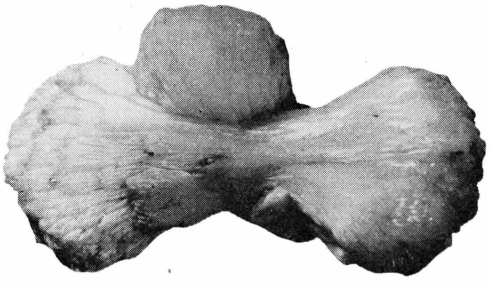


Fig. 81. Stilbite. Kuanerssuit. 1:1.

Tarajungitsoq (Giesecke 19-7-1813). Rather well-developed crystals found on heulandite in a cavity in tuff. Usual form, somewhat sheaf-like. The colour reddish.

Eqalúnguit (Giesecke 9-9-1811, Porsild 1915 and 1916). Giesecke's material consists of ordinary, sheaf-shaped crystals with rather insignificant faces. Porsild's material from 1915 consists of flat geodes without other minerals than s. In the middle there are sometimes cavities with small crystals. The material from 1916 undoubtedly represents the most considerable zeolite occurrence in Greenland. There is no surrounding rock; the original mineral is a thin layer of natrolite crystals, and upon those the stilbite is formed. A peculiar feature is that it occurs in two generations (fig. 82) as a rule without transitions; first a layer of very regular crystals, up to 3 cm in length and formed like thin plates with (010), (001) and (110). These crystals bear no trace of any sheaf-like growth, but scattered on it there are large (up to 7 cm in diameter) semi-spherical masses of radiating crystals, or possibly a few very deformed crystals. Outwardly they are not, like similar formations from the neighbourhood of Godhavn, bounded by (101) but exclusively by (110). The colour of the entire occurrence purely white.

Qarusuit (Steenstrup 1898). Crystallized with apophyllite and scolecite; the length up to 7 cm. The smaller crystals regularly developed,

(010), (001), (110) and (011); the larger ones sheaf-shaped with ($\bar{1}01$) projecting. The colour reddish or brownish-white.

Nangissat (Giesecke 1807). Somewhat varying material partly crystals (up to 1 cm) with chabazite and heulandite, and with (110) as terminal face; partly smaller crystals without other minerals, sheaf-shaped and with ($\bar{1}01$) as the only terminal face.

Sioraq (Porsild 1935). Rather large (up to 3 cm long) sheaf-shaped crystals; terminal face ($\bar{1}01$), the colour reddish.



Fig. 82. Stilbite. Eqalúnguit. 1:2.

Nordfjord, head of — (Porsild 1902). Crystals (about 1 cm long) bounded by (010), (001), (110) with very small faces of (011) and (101). The faces rather uneven, the colour reddish-white.

The Julianehaab district.

Josva's Copper Mine (Hoff).

Hoff: Om Alderen af de i Grønland optrædende geognostiske Formationer. 1864.

Among the numerous minerals accompanying the bornite and the chalcocite mention is made of a zeolite, probably stilbite.

Igdlorssuit (Sylow 1881). From a moraine originates a fragment of grey, fine-grained granite, on the fissures of which are found small (1—2 mm) crystals of stilbite; form (010), (001), (110) with a secondary ($\bar{1}01$); the faces curved, the colour faintly yellowish.

East-Greenland.

With the exception of the first one, all localities have been described by Bøggild: M. o. G. 28, 1909, pp. 116—120.

Kuteq (KNUTZEN 1893). On fissures in a grey granite very small crystals (about 1 mm) were found. Combination like the preceding occurrence; the colour greyish.

Henry Gletscher (O. NORDENSKJÖLD 1900). Small crystals of the usual shape in cavities in a basalt block in the moraine.

Henry Land (O. NORDENSKJÖLD 1900). Here various forms were found.

1. On the eastern side of Henry Bjerg were found a few crystals (up to 15 mm) on very small rock crystals. Sheaf-shaped, with ($\bar{1}01$) as terminal face. White, semi-transparent.

2. Also on the eastern side of Henry Bjerg, close to the shore large stilbite crystals were found in cavities coated with lithomarge and quite small rock crystals; rather large stilbite crystals (up to 3 cm) of the usual shape. Reddish, semi-transparent.

3. On the shore itself small crystals (about 5 cm) were found together with calcite. Whitish; brownish on the surface.

4. Near the hot spring small crystals (about 5 mm) were found together with thomsonite; the form the usual one.

Turner Sund (O. NORDENSKJÖLD 1900). Small crystals together with calcite; ordinary form (110) the only terminal face; brownish or reddish-white.

Turner Ø (O. NORDENSKJÖLD 1900).

1. From the inner end of Fyrbøderdal (ɔ: stokers' valley) a few (1—2 mm) crystals were found being of the usual form, clear and transparent.

2. At the top of the same valley larger crystals (up to 2 cm) together with natrolite and calcite; usual form. Faintly reddish-white, nearly untransparent.

Kap Brewster (O. NORDENSKJÖLD 1900). Rather large (up to 3 cm) greyish, semi-transparent, partly sheaf-shaped crystals, upon the whole imperfectly developed.

Gaasefjord (BAY 1891). On the southern side of the fjord granular s. was found, nearly filling out the entire space, in a few places with crystal faces. In other cases very small crystals (1—2 mm) were found together with levynite. Form essentially (010), (001), ($\bar{1}01$).

Gaaseland (BAY 1891). In a loose block together with chabazite.

Bontekoe Ø (MALMQUIST 1932). In loose blocks from the north-eastern side valley small crystals (about 2 mm) were found with chabazite. The crystals imperfectly developed, partly single, partly sheaf-like.

Brinkley Bjerg on Clavering Ø (Alex Jensen). On radiating groups of various fibred zeolites stilbite crystals are found. Form flat tables of up to 5 mm in length. Usual shape.

Sabine Ø (O. Nordenskjöld 1900). Small (1—3 mm) sheafllike reddish crystals.

217. Phillipsite. $(Ca,K_2)_{2\text{-}3}[Al_5(Al,Si)Si_9O_{30}].10H_2O$.

The Umanak district.

Hare Øen (Steenstrup 1873). In small cavities in amygdaloids; in other cavities chabazite and levynite. The size 0.5—1 mm. Form (100), (010), (001), (110), the latter narrow. Twins with twin plane (001). The faces most frequently well-developed and shining. Whitish, untransparent.

The Ritenbenk district.

Igdlukúnguaq (Porsild 1908). In a small loose-lying geode, which was sent in together with numerous similar specimens containing levynite, crystals were found of a dodecahedral form; the mineral is, however, strongly birefringent and bi-axial, positive, which agrees with p. The specific gravity is determined at 1.99, whereas it is otherwise for p. recorded at 2.2. The inconsiderable and incomplete material, however, does not permit of any more detailed determination of the mineral.

The Godhavn district.

Kuvnerssuaq. In a few cavities in basalt small (about 1 mm) crystals of dodecahedral shape are found; when seen under the microscope they are of a polysynthetic structure. The specific gravity is determined at 2.160, so it is presumably a question of phillipsite crystals.

218. Chabazite $(Ca,Na_2,K_2)[Al_2Si_4O_{12}].6H_2O$.

C. is very widely distributed in the basalt areas, more particularly on Disko; but everywhere small and insignificant. The most important forms are a $(11\bar{2}0)$, r $(10\bar{1}1)$, e $(01\bar{1}2)$, s $(02\bar{2}1)$, t $(11\bar{2}3)$; the term used for the ordinary twin formations is in the following tw. 1 for those with twin plane (0001), nearly always penetration twins, and tw. 2 for those with r $(10\bar{1}1)$ as a twin plane.

The Upernavik district.

Sukaussat (Rink). Crystals (up to 3 mm) in cavities and fissures in basalt, together with apophyllite and sometimes analcite r with a few very small faces of s; tw. 1 very common.

Kivsaq (Rink). Crystals essentially like the preceding, together with thomsonite.

Fastlandet (Rink). Very small crystals with apophyllite; in all essentials like the preceding.

The Umanak district.

Tuapagssuit (Steenstrup 1872). Small crystals (c. 5 mm) in cavities in dolerite without other minerals. All the crystals have a

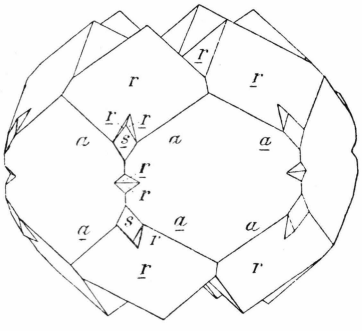


Fig. 83. Chabazite. Tuapagssuit.

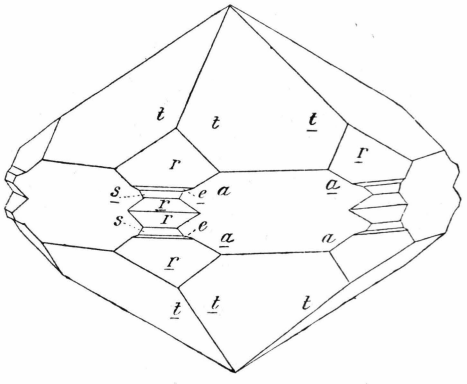


Fig. 84. Chabazite. Tuapagssuit.

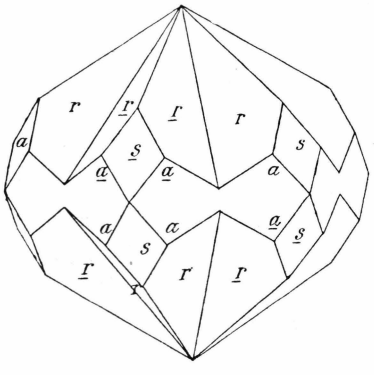


Fig. 85. Chabazite. Hare Øen.

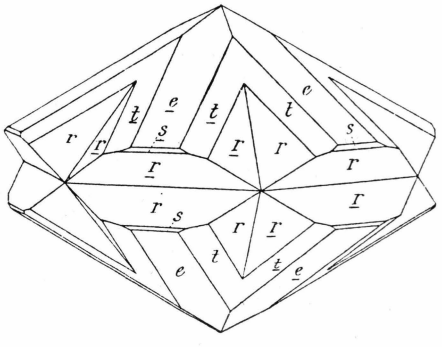


Fig. 86. Chabazite. Aumarûtigssat.

phacolite-form of two different types, as shown in the figures 83 and 84. The faces are rather badly developed and irregular; greyish, semi-transparent.

Kûk (Ravn 1909). Fillings of fissures in basalt; in cavities quite small (1—2 mm) crystals (*r*).

Kugssininguaq (Troelsen 1938). On a fissure in basalt there are numerous crystals (up to 5 mm) of c. A few tw. 1; the colour white.

Hare Øen (Giesecke 1811). Small (about 5 mm) greyish crystals together with natrolite and thomsonite. Developed as phacolite (fig. 85).

Aumarûtigssat (Steenstrup 1873). Crystals (5 mm) in cavities

in basalt; in neighbouring cavities levynite and calcite were found; most frequently the usual form *r* with tw. 1, and tw. 2, in a few cavities a phacolite form (fig. 86); besides the forms shown on the figure a scalenohedron ($21\bar{3}4$) is found, but more rarely.

The Ritenbenk district.

Tuapaussat (Rosenkrantz 1938). On a thin layer of thomsonite in semi-spherical groups there are numerous crystals of c. (about 2 mm); the colour white.

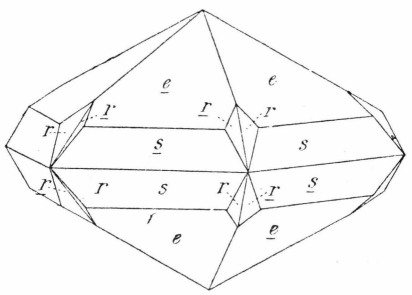


Fig. 87. Chabazite. Lyngmarken.

Nûngerut (Ravn 1909). At a height of 395 m the wall in a cavity was found coated with a thin layer of small heulandite crystals, on which c. (up to 4 mm); the colour yellowish-white.

Ujaragssuit (Steenstrup 1873). The largest Greenland crystals (up to about 3 cm in diameter) almost exclusively *r*, rarely with *e* and *s*. Twins rare; the colour white.

The Godhavn district

Puilasoq (Steenstrup 1872). Crystals (up to 7 mm) in brown basalt. Nearly exclusively *r*, very rarely *e*; hardly any twins; whitish.

Ivnarssuit (Giesecke 1807). Very small (2 mm) crystals together with apophyllite and stilbite, sometimes also thomsonite. Exclusively *r*, very rarely twins 1 and 2.

Brededal (Steenstrup 1872). Crystals (about 8 mm) with analcite; phacolite form, very much resembling fig. 84. The faces irregular, deeply striated.

Lyngmarken (Rink).

Rink: Ngr. p. 56.

Crystals (up to 1 cm) in brown basalt, together with lithomarge; the greater part of the crystals common, exclusively with *r*, without twin-formations. In a single cavity together with stilbite, characteristic phacolite forms were found as shown on fig. 87.

Blæsedal (Porsild 1915). The occurrence is somewhat differing from the usual one; it consists of a lump of coarse-grained calcite, the surface of which is greatly rounded, so that it seems to have been exposed to a strong erosion. Nevertheless a small spherical mass (5 mm) projects from one side, consisting of chabazite crystals, which are even uncommonly beautifully developed with shining faces, clear and colourless, only *r*.

Akiarut (Giesecke 14-5-1812). Sometimes small (about 3 mm) crystals with calcite and mesolite, sometimes larger (15 mm) without other minerals, *r* predominating, besides *e* and *s*, rarely *a*. Most frequently tw. 1.

Quvnerssuaq (Giesecke 30-8-1810, Steenstrup 1872). A phacolite form, greatly reminding of the one from Aumarútigssat (fig. 86). The faces well-developed.

Ũnartorssuaq (Giesecke 1-6-1807).

Tamnau: Monographie des Chabasits, 1836, p. 19.

This and the two following localities, lying very close to it seems to be the richest occurrences of c. in Greenland; *r* prevails (up to 15 mm) tw. 1 and tw. 2; these crystals occur together with stilbite, levynite, heulandite and calcite. Besides there are a great number of phacolite forms together with mesolite and calcite; the most usual combination is very regular, *r*, *s* and *e* prevailing, besides sometimes *t* and *a*. Semi-transparent, greyish or reddish.

Tuapagssuit (Steenstrup 1872). Crystallized in cavities in basalt without other minerals; the size about 5 mm. All the crystals have a phacolite form of two different types. The faces are as a rule very imperfectly developed and irregular; *r* and *t* are strongly striated. Greyish, semi-transparent.

Augpalârtoq (Giesecke 1807).

Tamnau: l. c.

Agrees in all respects with the preceding locality, from which it can hardly be distinguished with certainty. Tamnau mentions a number of different forms, as for instance *r*; also *r* with secondary *e* and a scalenohedron $(12\cdot1\cdot\bar{1}\bar{3}\cdot14)$, which forms a vicinal face with *r*, of which there is also elsewhere traces in the chabazite. Tamnau further mentions tw. 1 and tw. 2.

Blaafjeld (Steenstrup 1873). Crystals (about 5 mm) in amygdaloid, mostly *r* together with small faces of *e* and *s*, more rarely *a*. Frequently tw. 1 and tw. 2 and sometimes very nearly the same phacolite form as the crystals from Lyngmarken (fig. 87).

Ũnartoq (Steenstrup 1873). Crystals (about 5 mm) in amygdaloids; most frequently *r* together with heulandite and stilbite, tw. 1 and tw. 2, in other cavities phacolite, which rather approaches fig. 84, with *e*, *t* and *a* prevailing, while *s* and *r* are less pronounced.

Eqalúnguit (Giesecke 9-9-1811, Porsild 1915). Small (about 2 mm) crystals of the usual form; among the crystals and younger than those mesolite is found.

Qarusuit (Rink). Small (1—2 mm) together with mesolite; exclusively *r* with tw. 1 and tw. 2.

Nangissat (Giesecke 1807). Crystals (3—6 mm) with thomsonite and stilbite; nearly exclusively *r*, frequently tw. 1.

Avdlâgîssat (Porsild 1915). Whitish crystals (up to 5 mm) on an amorphous, rather clear, yellowish-brown mass. The latter has a refraction of about 1.495 and is surely a silicate, but it is hardly possible to determine it without an analysis. The crystals of c. are peculiar in that most of them are tw. 2, whereas there is not a single tw. 1.

Erqua (Porsild 1915). Small crystals (about 2 mm) on basalt; between them there is a whitish amorphous mass, the nature of which is not specified.

The Julianehaab district.

Kangerdluarssuk (Steenstrup). On a wall in a fissure in the nepheline-syenite there are very small (about 0.5 mm) crystals. The faces are not particularly well-developed, but the form is indubitable.

East-Greenland.

As to all localities, excepting of the last one, the reader is referred to Bøggild: M. o. G. 28, 1909, p. 125.

Iluileq (Eberlin 1884). On the drift-ice small crystals (2—5 mm) were found in cavities in basalt; form *r* with tw. 1 and tw. 2.

Henry Gletscher (O. Nordenskjöld 1900). In loose blocks in the moraine small (2—5 mm) crystals were found together with stilbite, heulandite, levynite and thomsonite. Nearly exclusively *r*, more rarely *a*, *s* and *e*; tw. 1 and tw. 2.

Henry Land, eastern side of — (O. Nordenskjöld 1900). Small (about 2 mm) crystals with *r* and sometimes *e*; tw. 1.

Sydbræ (Bay 1891—92). Small (2—5 mm) together with apophyllite and thomsonite; *r* with a few tw. 1.

Gaasefjord (Bay 1891—92). On the northern side of this fjord crystals are found together with thomsonite. Nearly exclusively *r* with

tw. 1 and tw. 2. On the southern side partly the same forms were found, partly quite small (1—2 mm) crystals, which besides *r* had well-developed *a*, *s* and *e*.

Danmarks Ø (Bay 1891—92). Small crystals partly together with calcite; nearly exclusively *r*.

Kap Bror Ruys (Rosenkrantz 1945). On Uglehøjen (ɔ: the owl's hill) to the west of this place small (1—2 mm) crystals were found in cavities in basalt. The form only *r*.

Bontekoe Ø (Malmquist 1932). On loose blocks from Nordøst-Sidedalen (ɔ: the north-eastern side valley) were found small crystals together with stilbite and other minerals. The only form *r*; no twin formations.

219. Levynite. $Ca[Al_2Si_3O_{10}].5H_2O$

L. is of rather common occurrence in the basalt areas. The crystals, which are always small and inconsiderable, nearly always have the same form, in so far as the frequently rather indistinct marginal faces permit of determination. The form is tabular along the base and with *s* (0221) and *r* (1011) at the margin; nearly always penetration twins.

The Upernavik district.

Ingnerit Fjord (Rink). Crystals (up to 4 mm) in a greatly vesicular basalt. The form as described above; the faces of the base shining the other faces dull and curved.

The Umanak district.

Aumarûtigssat (Steenstrup 1873). Crystals (up to 3 mm) together with a few calcite crystals; in other cavities chabazite, thomsonite and phillipsite; the faces very irregular and curved.

The Ritenbenk district.

Ujaragssuit (Steenstrup 1872). Crystals (up to 6 mm) together with a few calcite crystals; in other cavities chabazite and analcite were found.

Igdlukúnguaq (Porsild 1902). A number of small geodes, on the outside provided with a brown crust. Crystals (up to 3 mm) bounded by the usual faces, but without twin formation. Some of the crystals show a peculiar phenomenon, which can also be observed from other localities, viz. that the basal faces are coated with a fibrous layer, so that on the broken crystals there is a strongly glistening streak on each side of the fracture. An investigation by means of a microscope shows that it is the actual levynite substance which passes into these fibres

with the same orientation as in the middle of the crystals; thus, there is a porous outer zone in these quite sharply bounded layers.

The Godhavn district.

Puilasoq (Steenstrup 1872). Crystals (up to 3 mm); in neighbouring cavities chabazite is found. The faces irregular, curved and striated.

Lyngmarken (Rink). Crystals (up to 7 mm) together with lithomarge; in neighbouring cavities chabazite. The faces well-developed.

Akiarut (Giesecke 1812).

Mohs: Naturgeschichte des Mineralreiches 1839, p. 257.

Crystals (up to 8 mm) with irregular faces. It is possibly this occurrence, which is mentioned by Mohs, who names the mineral "Makrotyper Kuphon-Spath"; he mentions no locality, but in Dana's and other manuals the mineral is recorded from Godhavn.

Kuvnerssuaq (Steenstrup 1872). Crystals (up to 7 mm); in adjoining cavities chabazite. No rhombohedral faces are observed; the basal faces coated with the same silky layer, which has been mentioned above.

Ũnartorssuaq (Giesecke). Crystals (up to 5 mm) in cavities as very thin tables together with chabazite; in other cavities the crystals have the above-mentioned coating.

Blaafjeld (Steenstrup 1872). Crystals (up to 5 mm) without other zeolites.

Qarusuit (Steenstrup 1873) like the preceding occurrence.

Iginiarfik (Steenstrup 1898).

Steenstrup: M. o. G. 24, 1901, p. 285.

Recorded to have been together with several other zeolites in a red tuff-like amygdaloid.

Ivisârqut (Porsild 1902). Crystals (up to 7 mm); in other cavities chabazite. The crystals are coated with the silky layer which has been mentioned on former occasions.

East-Greenland.

Iluileq (Eberlin 1884).

Bøggild: M. o. G. 28, 1909, p. 128.

Crystals (2—3 mm), twins with tw. pl. (0001) though not penetration twins. The basal faces coated with the formerly mentioned layer. The faces well-developed.

Henry Gletscher (O. Nordenskjöld 1900).

Bøggild: l. c.

In loose blocks in the moraine together with thomsonite; in neighbouring cavities also chabazite and stilbite. Size 1—2 mm; the form rather the usual one, but the rhombohedral faces are here in an unusual degree replaced by vicinal faces, which fairly well agree with $(2\cdot10\cdot\overline{12}\cdot7)$ and $(10\cdot2\cdot\overline{12}\cdot11)$.

Gaasefjord (Bay 1891—92).

Small (1—3 mm) crystals in grey dolerite, partly together with stilbite and chabazite. The greater part of the crystals are clear and transparent, but on a few of them the surface is coated with the formerly mentioned silky layer.

Kap Bror Ruys (Rosenkrantz 1945). On "Uglehøjen" to the west of this locality small crystals were found in cavities at a height of 100 m; in neighbouring cavities chabazite was found. No distinct marginal bounding; the formerly mentioned silky layer was found.

X. ORGANIC COMPOUNDS

220. Whewellite. $Ca[C_2O_4] \cdot H_2O$.

The Umanak district.

Kangilia (ERIKSEN 1939). In a calcareous concretion from a bituminous slate there was a shell of a rather large sea-urchin (largest diameter about 7 cm) the interior of which is filled with a mixture, mainly composed of white crystals of w. with somewhat smaller quantities of dark-brown barite crystals and a few yellowish calcite crystals. These three minerals are apparently lying quite at random, and it is impossible to say anything as to their succession of formation. Most of the grains are without any outward crystal bounding, and this applies to all three minerals.

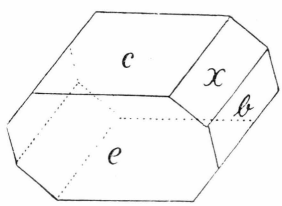


Fig. 88. Whewellite. Kangilia.

The crystals of w. are tabular in form, their width being up to 1 cm and their thickness up to 2 mm; as far as can be seen they are flattened parallel with $(\bar{1}01)$, but the faces are as a rule very incompletely plane and there are no regular marginal faces, with the exception of cleavage planes parallel with (010). Only a single crystal has been found with well-developed faces and of a regular shape, which is very rare in the mineral. Even though the faces found c (001), e $(\bar{1}01)$, b (010) and x (011) are among the most commonly occurring, no crystals are known to have developed in such a manner as shown on fig. 88. Owing to the good reflexes it has been possible to determine the faces with absolute certainty.

The specific gravity has been determined at 2.19, both for the crystal mentioned above and for the remaining material; the colour is purely white or in a few cases faintly yellowish. No traces of twin formation

have been found, which formations is otherwise very common in the mineral.

221. Retinite. $C_6H_{10}O$?

R. is a common appellation for a number of substances which do not differ much from succinite in composition, but as distinguished from the latter do not contain succinic acid. Various forms of r. have been given a number of different names, but it is surely impossible to distinguish them from each other. R. is found in some of the cavities in the lignite beds on Nûgssuaq and Disko; it is always very brittle, so that it cannot be used for ornaments.

The Umanak district.

Ikorfat (Rosenkrantz 1938). Small grains in lignite.

Alianaitsunguaq (Rosenkrantz 1939). A single small grain, 5 mm long, found in a sandstone containing plant-fossils.

Hare Øen (Giesecke 1-7-1811).

Chydenius: Geol. Fören. Förh. Stockholm, 2, 1875, p. 249.

Numerous irregularly shaped, small (about 2 cm) grains in lignite; the colour most frequently deep-brown, sometimes paler, sometimes nearly black. Specific gravity 1.091. Chydenius has subjected the material to a more detailed investigation and found that succinic acid was not formed by destillation, and that 48.4 % is dissoluble in ether. Analyses undertaken yielded the following result: C 74.44, H 10.46, and C 73.01, H 10.35 which, presuming that the remainder is O, gives approximately the formula $C_6H_{10}O$.

Another examination of Greenland r. without specified locality has been undertaken by Helm (Schr. d. Naturf. Gesell. Danzig, Neue F, 7. 1891, p. 201) which describes it as decomposed orange-red to brownish-red grains; specific gravity 1.051; by means of dry destillation a small amount of succinic acid was formed.

The Ritenbenk district.

Atanikerdluk (Rink).

Rink: Ngr. p. 49.

In all essentials resembling the preceding locality.

Arsarak (Steenstrup 1873). Found as fillings in fissures (about 1 cm thick) in coal-bearing clay; most frequently rather clear, of a brownish colour.

Ũnartuarssuk (Hartz 1891). Irregularly formed masses (up to 3 cm) in sandstone-schist; particularly clear and transparent golden-brown. Specific gravity 1.055.

Ujaragsugssuk (Hartz 1891). In all essentials like the preceding locality.

ALPHABETICAL LIST OF THE LOCALITIES

The names of the districts are given as follows.

Thule	T.	Egedesminde	Eg.
Upernavik	Up.	Holsteinsborg	H.
Umanak	Um.	Sukkertoppen	S.
Ritenbenk	R.	Godthaab	Gb.
Godhavn	Gn.	Frederikshaab	F.
Jakobshavn	Jn.	Julianehaab	Jb.
Christianshaab	C.	East-Greenland	E.

Agatdalen. Um. 115. 121.
Agpaliarssuit. Jb. 63.
Agpat. Um. 367.
Agto. Eg. 62. 100. 269. 370. 384.
Akajamineq. Gb. 166.
Akia. E. 210. 219. 226.
Akia. Jb. 47. 324.
Akia. Um. 155. 165. 167. 168. 196. 393.
Akiarut. Gn. 316. 352. 358. 397. 401. 405. 406. 411. 414. 421. 424.
Akitseq. E. 225.
Akugdleq. C. 122.
Akugdleq. H. 265.
Akugdlît. C. 267. 286.
Akugdlît. Eg. 50. 57. 144. 176. 225. 268. 284. 287. 368. 388. 394.
Akugdlît. Um. 172. 286. 301.
Akuliaruseq. Jb. 330. 356.
Akuliaruseq. Um. 301.
Akuliaruserssuaq. Eg. 150.
Akuliarusiarssuk. Jb. 377.
Akunâq. Eg. 368.
Alangorssuaq. Gb. 62. 303.
Alianaitsunguaq. Um. 427.
Aliortoq. Gb. 187. 208. 304. 365. 371. 382.
Aluit. E. 332.
Aluk. E. 237.
Ameralik. Gb. 58. 187. 199.
Amitsoq. Jb. 37. 236. 366.
Amitsuarssuk. Gb. 287. 323.
Anarsuit. Gn. 405.
Anartuarssuk. R. 357.
Anâva. E. 202.
Angmagssalik. E. 63. 381.
Angnertuneq. Um. 121. 149. 169. 172. 314. 350.
Anguiartoutit. Gn. 407. 415.
Anoritôq. Jn. 29. 224.
Anoritôq. Um. 175. 299. 320. 361.
Arferssuaq. E. 332. 377.
Arfitsiaq. Up. 195. 259.
Arsarak. R. 427.
Arssalik. H. 270.
Arsuk Fjord. F. 109. 329.
Arsuk Storø. F. 105. 107. 109. 135. 138. 167.
Arsuk Ø. F. 37. 294. 379. 389.
Arveprinsens Ejland. R. 20.
Asardlut. Jb. 344.
Asuk. R. 20. 121. 259. 277. 346.
Atâ. Jn. 321.
Atâ. R. 404.
Ataneq. Gb. 322.
Atangmik. S. 62. 186. 322. 342.
Atanikerdluk. R. 135. 137. 427.
Atilik. Jn. 116.
Augpalârtoq. Eg. 50. 268. 394.
Augpalârtoq. Gn. 346. 421.

Aumarùtigssat. Um. 144. 153. 419. 423.
Aunikasik. Gb. 136. 187. 278. 304. 323. 333. 384.
Auspicia. E. 59.
Auvaitsersarfik. Gb. 102. 107. 192. 199. 260. 305. 385.
Auvfarssuaq. Um. 160.
Avataussaligssuaq. Um. 115.
Avdlâgîssat. Gn. 196. 422.
Avigait. F. 208. 217. 254.

Bings Hul. C. 368. 379.
Birds Bay. E. 281.
Bjørneø. Gb. 51. 233. 303.
Blaa Elv. E. 171.
Blaafjeld. Gn. 407. 414. 421. 424.
Blæsedal. Gn. 349. 421.
Bontekoe Ø. E. 417. 423.
Brededal. Gn. 315. 357. 420.
Brinkley Bjerg. E. 127. 406. 418.
Broget Dal. E. 64.

Canning Land. E. 164.
Cape see Kap.
Carey Øer. T. 144.
Carlshavn. E. 123. 126. 140.
Claushavn. C. 39. 46. 127. 267. 286. 393.
Clavering Ø. E. 378. 402. 406.

Dallas Bay. T. 108.
Danmarks Ø. E. 147. 189. 423.
De Dødes Fjord. T. 108.
Disko. R. or Gn. 240. 327.
Disko Fjord. Gn. 12.
Dronning Louises Ø. E. 120. 179. 189. 237. 377.
Døde Hus Plads. E. 120. 206. 381.

Egedesminde. Eg. 284.
Ella Ø. E. 148. 170.
Engelskmandens Havn. Gn. 341. 383.
Eqalugârssuit. H. 155.
Eqalugssuit. Eg. 36. 101. 150. 177. 185. 188. 225. 278. 332. 334. 344. 385. 394.
Eqalugssuit. H. 269. 278.
Eqaluit. C. 176. 302. 384.
Eqaluit. F. 236.
Eqaluit. Gn. 50. 122.
Eqaluit. Um. 19.
Eqalunguakat. Gn. 407.
Eqalúnguit. Gb. 233. 257.
Eqalúnguit. Gn. 122. 317. 401. 415. 422.
Eqùtit. Eg. 196.
Erdluat Qeqertat. Jb. 236.
Erqordleq. Up. 259.
Erqua. Gn. 401. 422.
Evqitsoq. Gn. 349.

Falske Bugt. E. 148. 151.
Fastlandet. Up. 313. 357. 403. 419.
Finsch Øer. E. 165.
Fiskenæsset. Gb. 30. 52. 62. 102. 107. 113. 127. 154. 193. 200. 208. 217. 225. 230. 278. 300. 304. 306. 329. 335.
Fiskenæsset District. Gb. 280. 288. 300.
Flakke Bugt. E. 120. 153.
Fleming Fjord. E. 39. 99.
Fortunebay. Gn. 21. 57. 165. 203. 263. 302. 320. 334. 367.
Franz Josephs Fjord. E. 211.
Frederik VII's Mine. Jb. 14. 41. 154.
Frederiksdal (Friedrichsthal). Jb. 179. 281.
Frederikshaab. F. 173. 395.
Frederikshaab Isblink. F. 112. 187. 311. 355.
Fyrbøderdal. E. 417.

Gaasefjord. E. 147. 405. 410. 417. 422. 425.
Gaaseland. E. 413. 417.
Geolog Fjord. E. 64. 123.
Gipselv. E. 170.
Gneiss Canon. E. 188. 395.
Godhavn. Gn. 45. 57. 240. 283. 317. 358. 407.
Godhavn Peninsula. Gn. 367.
Godthaab. Gb. 262. 370.
Granville Fjord. T. 55.
Grisebugt. Up. 104. 154. 383.
Grusgraven. E. 102. 188.
Grønnedal. F. 106. 112. 270. 355. 388. 390.

Hamites Ravine. Um. 115.
Hareøen. Eg. 268. 302.
Hareøen. Um. 126. 144. 314. 404. 406. 413. 418. 419. 427.
Henry Bjerg. E. 147. 401. 402. 407. 412. 417.

Henry Gletscher. E. 120. 405. 412. 417. 422. 425.
Henry Land. E. 360. 405. 408. 417. 422.
Hjortetakken. Gb. 303. 382. 395.
Hochstetters Forland. E. 59. 148.
Hold with Hope. E. 153.
Holms Ø. T. 64.
Holsteinsborg. H. 166. 270. 334.
Hunde Ejland. Eg. 30.
Hvalfiske Ejland. Gn. 45. 261.

Igaliko. Jb. 58. 70. 110. 119. 164. 181. 256. 280. 356. 364. 390.
Igaliko Fjord. Jb. 45. 53. 70.
Iganeq. Jb. 107.
Igaussaq. F. 170.
Igdlerfigssalik. Jb. 112. 218.
Igdlordluit. Gb. 395.
Igdlorliusalik. Jb. 275.
Igdlorpait. Jb. 132. 258.
Igdlorssuit. Gb. 155. 177. 207. 217.
Igdlorssuit. H. 370.
Igdlorssuit. Jb. 416.
Igdlorssuit. Um. 313. 349.
Igdlukúnguaq. R. 42. 45. 49. 52. 54. 59. 104. 137. 160. 404. 418. 423.
Igdlúnguaq. Jb. 179. 228. 256. 400.
Iginiarfik. Eg. 269. 299.
Iginiarfik. Gn. 412. 424.
Igpik. Gn. 153. 341. 358. 411.
Igpik. Um. 406.
Ika. F. 139.
Ikamiut. C. or Eg. 111. 176. 232. 342. 383.
Ikarissat. Gb. 342.
Ikáteq. E. 305. 332. 336. 343.
Ikátoq. Gb. 200. 304. 323. 343. 371.
Ikátoq Quvnilik. Gb. 137.
Ikerasaq. E. 38.
Ikerasaq. Um. 176. 334.
Ikerasarssuk. Eg. 370.
Ikertôq. H. 302.
Ikertôq Fjord. H. 137.
Ikorfat. Um. 152. 350. 397. 403. 427.
Ilaliánguit. E. 225.
Ilimaussaq. Jb. 41. 201.
Ilua. Jb. 119. 236.
Iluilârssuk. F. 62. 344.
Iluileq. E. 146. 412. 422. 424.
Ingitait. Eg. 210.
Ingnangnaq. R. 315. 351. 357.
Ingnerit. Up. 55.
Ingnerit Fjord. Up. 423.
Inigssalik. E. 325.
Inuarugdligaq. Jb. 146.
Inugsuit. E. 63. 219. 226.
Inugsuk Varde. F. 177.
Inugsulik. Eg. 105. 177. 206. 216. 369. 383. 394.
Ipiutaq. Jb. 118. 201. 358.
Isortoq Fjord. S. 170.
Isua. C. 203. 260. 267. 286.
Isuamiut. Eg. 57. 144. 170. 192. 286.
Isunguaq. R. 57.
Itivdleq Valley. H. 162.
Itivdliarssuk. Gn. 127.
Itivdliarssuk. Um. 277. 286.
Itivdliatsiaq. Jb. 386.
Itivdlinguaq. S. 155.
Itivdlinguaq. Um. 301.
Itivneq. H. 162.
Itivnera. Gb. 304.
Iviangusat. Jb. 223.
Ivigtut. F. 14. 32. 43. 46. 47. 48. 51. 52. 53. 54. 58. 60. 63. 66. 70. 72. 73. 74. 84. 86. 87. 88. 89. 91. 94. 97. 106. 109. 117. 123. 128. 129. 134. 138. 155. 163. 173. 174. 189. 209. 217. 326. 329. 371.
Ivinquit. Jb. 117.
Ivisârqut. Gn. 28. 424.
Ivnajuagtoq. Gb. 253.
Ivnarssuaq. Um. 48.
Ivnarssuit. Gn. 316. 351. 397. 414. 420.
Ivnârssulik. Eg. 65.
Ivnârssulik. Gn. 176.
Ivnatsiaq. Jb. 47. 145. 209. 218. 290.
Ivssugigssoq. T. 319.

Jakobshavn. Jn. 29. 283.
Jernpynten. Gn. 28.
Josva's Copper Mine. Jb. 13. 40. 68. 145. 154. 155. 201. 205. 263. 386. 416.
Julianehaab. Jb. 70. 155. 258. 339.
Jørgen Brøndlunds Fjord. E. 33. 59. 171. 173.

Kalitaut. Jb. 236.
Kanajormiut. Jb. 335.
Kanajorssuit. Gb. 361. 382.
Kangamiut. S. 37.
Kangârssuk. F. 58. 60. 63. 344. 371.
Kangatsiak. Eg. 105.
Kangeq. Jb. 132. 261.

Kangerajuk. E. 202. 261.
Kangerdluarssuk. Gn. 358.
Kangerdluarssuk. H. 32. 40. 46. 48. 54. 55. 103. 287. 302.
Kangerdluarssuk. Jb. 44. 61. 63. 69. 129. 178. 180. 216. 228. 241. 263. 279. 298. 312. 343. 361. 396. 422.
Kangerdluarssuk (Region of —). Jb. 44. 110. 134. 178. 180. 214. 220. 226. 227. 238. 241. 245. 247. 253. 256. 263. 273. 289. 291. 296. 307. 338. 355. 359. 376. 378. 380. 388. 390. 396. 399.
Kangerdluarssuk. R. 136.
Kangerdluarssugssuaq. Jn. 321.
Kangerdlugssuaq. S. 111. 303.
Kangerdluluk. C. 150. 176. 214. 302.
Kangersuneq. C. 127. 232. 284.
Kangilia. Um. 115. 121. 163. 169. 172. 401. 403. 426.
Kangve. Jb. 41.
Kaniorqat. Um. 136. 142. 152.
Kaniuaq. Um. 183.
Kap Adelaer. E. 226. 270. 288. 412.
Kap Alexander. T. 175. 413.
Kap Arends. E. 237. 382. 383.
Kap Bille. E. 210. 220. 226.
Kap Brewster. E. 123. 147. 317. 360. 401. 402. 405. 412. 417.
Kap Broer Ruys. E. 148. 423. 425.
Kap Brown. E. 148.
Kap Dalton. E. 120. 123. 147.
Kap Daniel Rantzau. E. 111.
Kap Farvel. Jb. 119. 301.
Kap Franklin. E. 70. 151. 163. 170.
Kap Hedlund. E. 336.
Kap Hope. E. 147.
Kapisilik. Gb. 186. 204.
Kap Ivar Huitfeldt. E. 108. 261.
Kap Løwenørn. E. 147.
Kap Oswald. E. 148.
Kap Parry. T. 48. 55. 275.
Kap Rantzau. E. 210. 216.
Kap Stosch. E. 148. 171.
Kap Tordenskjold. E. 226.
Kap Walløe. E. 61.
Kap York. T. 14. 31. 48. 103. 108. 175. 413.
Karartut. Gn. 316. 411. 414.
Karra Akungnak (Akungnait). E. 131. 210. 220. 226. 237. 258. 281. 377.
Kasigianguit. Gb. 305.
Kiatak. T. 18. 45.
Kiataq. E. 147.
Kilertinguaq. Um. 313. 357.
Kilingarsuaq. Gb. 371.
Kinalik. Jb. 377.
Kingigtoq. F. 136. 209. 217. 288. 323. 344.
Kingigtoq. Jb. 47. 206. 374.
Kingokotala Qingua. Jb. 109. 118.
Kitsigsut Øer. Jb. 104. 219. 251. 407.
Kivsaq. Up. 418.
Klitdalen. E. 39. 170.
Klokkerhuk. R. 263.
Knudshoved. E. 123.
Kobberpynt. E. 325.
Kolinguaq (Kûlinguaq). Gb. 46. 51. 145. 200. 204.
Kongeborgen. E. 164.
Kong Oscars Havn. E. 279. 281.
Kronprinsens Ejland. Gn. 46. 50. 65. 144.
Kuanerssuit. Gn. 317. 415.
Kuanit. Gn. 410.
Kûgánguaq. R. 20. 49. 121. 153. 413.
Kugssineq angnertuneq. Um. 34.
Kugssininguaq. Um. 115. 314. 411. 419.
Kugssuaq. S. 303. 322.
Kûk. Um. 167. 172. 419.
Kulhus. E. 149.
Kûlinguaq. Gb. see Kolinguaq.
Kumaq. E. 395.
Kumerngit. Jb. 249. 376.
Kungnait (Kûnait). F. 117. 365.
Kutdligssat. R. 115. 122.
Kuteq. E. 417.
Kuvnerssuaq. Gb. 322.
Kuvnerssuaq. Gn. 424.
Kvanefjord. F. 46. 204.
Kællingehætten. H. 111. 280.

Lakseelven. Jb. 296.
Langø. Up. 33. 55. 165. 196. 259. 361. 367.
Lichtenau. Jb. 201. 343.
Littleton Ø. T. 367.
Liverpool Land. E. 102. 110. 170. 188. 395.
Lyngmarken. Gn. 346. 404. 414. 420. 424.
Lyngmarksfjeld. Gn. 397. 401. 404. 407. 414.

Maanedalen. E. 151.
Maligissap Qava. H. 225. 302. 394.
Manîtsoq. Eg. 57. 62. 183. 192. 197. 224. 233. 262. 267. 284. 286. 294. 321. 328. 379. 382. 383. 384. 394.
Mannik. Gb. 287.
Marmorilik. Um. 34. 43. 52. 56. 65. 141. 283. 320. 393.
Marrait. Um. 239. 314. 320. 345. 397.
Marraq. Gn. 122.
Marraq. R. 49.
Mellemfjord. Gn. 28. 346. 358.
Milne Land. E. 264.
Missame. Jb. 41.
Mussartût. Jb. 68. 118. 164. 184.

Nagsugtôq = Nordre Strømfjord.
Nagtoralik. E. 120. 202. 237. 377.
Nâlagánguaq. H. 105.
Nalagûtoq. Jb. 377.
Nangissat. Gn. 408. 412. 416. 422.
Nanortalik. Jb. 37. 61. 188. 201. 236. 261. 377.
Nanûseq. E. 189.
Naqerdlok (Nakerdluk). Um. 120. 357. 397.
Narssaq. Gb. 62. 135. 200. 204. 208. 270. 323. 395.
Narssaq. Jb. 205.
Narssârssuk. Jb. 37. 44. 53. 68. 106. 111. 112. 113. 119. 129. 139. 140. 145. 154. 155. 158. 160. 177. 205. 218. 223. 237. 238. 243. 245. 251. 254. 264. 271. 288. 290. 295. 298. 301. 307. 309. 310. 311. 318. 335. 336. 339. 340. 343. 359. 362. 366. 375. 379. 398. 410.
Narssarssúnguaq. Um. 115.
Narssatsiaq. Gb. 270. 287. 300. 308. 322. 334.
Natdluarssuk. Um. 413.
Natdlusivik. S. 46. 52.
Nathorst Fjeld. E. 182.
Naujakasik. Jb. 44. 60. 179. 180. 213. 222. 228. 242. 248. 298. 307. 347. 363.
Naujanguit. Gb. 197. 287. 303.
Naujat. Jb. 129.
Naujat. Up. 65.
Niaqornaq. Jn. 28. 31.
Niaqornaq. Eg. 382.
Niaqornârssuk. Jb. 106. 177. 258. 264. 317. 361.
Niaqornârssuk. Um. 121. 150. 314. 350. 404.
Niaqornat. Um. 35. 103. 115. 134. 141. 149. 152. 160. 169. 240. 262. 314. 327. 350. 353. 393.
Niaqorssuaq. Um. 141.
Nipisat Sund. H. 36.
Nordfjord. Gn. 116. 144. 416.
Nordre Strømfjord. Eg. 36. 57. 101. 185. 205. 225. 269. 333. 334. 344. 394.
North Kitsigsut Islands. Jb. 106.
North Siorarssuit. Jb. 68. 205. 238. 242.
North Star Bay. T. 149. 163.
North Strøm Fjord = Nordre Strømfjord.
Nûgârsuk. Gb. 197.
Nûgâtsiaq. Eg. 206. 217.
Nûgssuaq. H. 36.
Nûgssuaq. Um. 123. 142. 153.
Nûgssuaq Peninsula. Um. 143.
Nûk. C. 105. 127. 131. 176. 189. 191. 196. 203. 232. 260. 267. 283. 286. 299. 302. 321. 351.
Nûk. E. 270.
Nûk. Um. 19. 351.
Nûluk. Um. 413.
Nûluk. Up. 384.
Nunarssuatsiaq. Jb. 44. 133. 179. 180. 212. 227. 228. 263. 292.
Nunarssuit. Jb. 68. 69. 106. 270. 290. 330. 335. 372. 374. 395.
Nunasarnaq. Jb. 41. 139. 220. 263.
Nunasarnaussaq. Jb. 53. 69. 135. 139. 146. 205. 264. 296. 382.
Nûngerut. R. 351. 357. 409. 411. 420.
Nussaq. Jb. 351.
Nutarmiut. Up. 110.
Nyeboe's Kanal. Jb. 379.
Ny Herrnhut. Gb. 395.

Oriartorfik. Gb. 323.
Orkusaq. Jb. 146.
Orpigsôq. C. 267. 284. 384.
Orpît Qâqât. Gn. 144. 412.

Pâkitsoq. Jn. 299. 321.
Panernak. Jb. 58. 68.
Paornakajît. E. 279. 304.
Paornat. Um. 56.
Paotût. R. 108.
Pardlit. Jb. 63.
Payers Tinde. E. 202.

Pendulum Øer. E. 123. 148.
Per Dams Skib. Gn. 126. 315.
Pinguarssuk. Gb. 323.
Pisigsarfik. Gb. 155.
Polaris Bay (Havn). T. 195. 259. 265.
Port Foulke. T. 51. 99. 183. 195. 265.
Portusoq. Jb. 218.
Portusut. E. 105.
Prøven. Up. 114. 141. 152. 262.
Puagiarsuk. C. 111. 232. 342.
Puilasoq. Gn. 411. 420. 424.
Puissortoq. E. 132.
Pujortoq. Um. 32. 162. 168. 169.

Qaersoq. Jb. 110.
Qaersuarssuk. Um. 35. 341. 397. 403.
Qaersut. Um. 19. 34. 56. 176. 185. 275. 296. 357.
Qagssiarssuk. Jb. 219. 275.
Qagssimiut. Jb. 374. 386.
Qapiortoq Kitdleq. Um. 160.
Qáqaligaitsiaq. Jb. 68.
Qáqap Qârssua. Um. 142. 314.
Qáqarssuatsiaq. E. 209. 219.
Qáqarssuit. Eg. 197. 299.
Qáqarssuit. C. 288.
Qaqortoq. Eg. 368.
Qaqortoq. F. 236.
Qaqortúnguaq. F. 129.
Qarajak Fjord. Um. 320.
Qarajap Ilua. Gb. 151. 278. 335. 370.
Qarajap Qingua. Gb. 344.
Qarajat. Gb. 62. 187. 235. 258. 278. 287. 304. 323. 329. 333. 342.
Qarartut. Gn. 351.
Qarssuanguit-qaqait. Gn. 358. 402. 405. 407.
Qârusuit. Gn. 122. 137. 317. 349. 352. 358. 401. 407. 415. 422. 424.
Qarusuk. Gb. 197. 323.
Qarusulik. Gb. 233. 334.
Qasigiánguit (at Ameralik). Gb. 183. 329. 371. 385.
Qasigiánguit (at Godthaab). Gb. 257. 260.
Qasigissat. E. 188.
Qasingortoq. E. 219. 226.
Qeqeq. Gn. 358.
Qeqertánguaq. Gb. 46. 58. 198. 208. 238.
Qeqertaq. F. 304.
Qeqertaq. Jb. 179.
Qeqertaq. Up. 175. 276.
Qeqertarssuaq. Eg. 285.
Qeqertarssuaq. Jb. 209.
Qeqertarssuaq. Um. 262.
Qeqertarssuatsiaq. E. 377.
Qeqertarssuatsiaq. Eg. 36. 233.
Qeqertarssugssuk. C. 232. 294.
Qeqertarssurssuaq. Jb. 251. 281. 356.
Qeqertatsiaq. S. 166.
Qeqertaussaq. Jb. 227. 264.
Qernertit. Jb. 206.
Qilangárssuaq. Gb. 208. 217.
Qilaussat. Gb. 155.
Qilertinguit. Um. 127.
Qipingajak. E. 201.
Qipisarqo. F. 107.
Qitdlussat Nûa. Gb. 50.
Qivssâq. Up. 403. 418.
Qôrnoq Fjord. Gb. 177.
Qôroq. Gb. 303. 305.
Qôroq. Jb. 106. 361.
Qôrorssuaq. Gn. 316. 352.
Qôrorssuaq. Jb. 182. 271. 295.
Qôrortussoq. H. 197.
Qutdligssat. R. 115. 144. 315. 321. 348. 357.
Quvnerssuaq. Gn. 421.

Raadne Klipper F. 128..
Raukelejren. E. 148.
Red Head. T. 43. 55.
Redekammen. Jb. 250.
Renodde. E. 237.
Renø. Jb. 324.
Ritenbenk. R. 104. 378.
Ritenbenk Coal Mine. R. 20. 153. 240. 315. 345. 357.
Ruds Ø. E. 210.
Runde Fjeld. E. 202.
Rypefjeld. E. 378.
Røde Elv. Gn. 317. 407. 414.
Røde Kløft. Um. 150.

Sabine Ø. E. 120. 123. 153. 418.
Sadlen. Gb. 177.
Sagdleq. C. 394.
Sagdliaruseq. Jb. 68. 109. 118.
Saituaraq. C. 328.
Sakordleq. Eg. 328.
Sânerut. F. 40.
Sangmissoq. E. 61.

Sangmissoq. Jb. 209.
Sangmissoq. Um. 121. 142. 357.
Sârdlat. C. 342.
Sârdloq. Jb. 132. 258.
Sarfánguaq. H. 144. 278. 302.
Sarfarfik. Um. 266. 283. 320.
Sarfârssuit. R. 315. 357. 408.
Sarfârssuit. Um. 196.
Sarfârssuk. R. 239. 351. 397.
Sarkanguaq. Gn. 346.
Sarpiussaq (Sarpiussat). C. 111. 176.
Sarqap nùa. E. 202.
Sarqaq. Um. 114.
Sarqaq's Kangerdluarssuk = Kangerdluarssuk. H.
Sâtúnguit. Um. 224. 266. 286. 367.
Savik. T. 18.
Scaphites Ravine. Um. 115.
Serfat. Um. 14. 152.
Sermermiut. Jn. 30. 182.
Sermersôq F. 323.
Sermersôq. Gn. 367.
Sermersôq. Jb. 261.
Sermersôq. Um. 408.
Sermiligârssuk. F. 172.
Shannon Ø. E. 154.
Sidlisit. Gb. 323.
Sigssardlugtoq. Jb. 324.
Sigssarigssoq. Jb. 38.
Sigssarigsut. Jn. 230.
Simiutaq. Gb. 105. 235. 261.
Simiutaq Kua. Up. 403.
Simiutarssuaq. Eg. 370.
Sioraq. Gn. 50. 416.
Siorarssuit (North or South?). Jb. 365.
Siorarssuit. S. 103. 186. 300.
Siorartussoq. Jb. 201.
Skandsen. Gn. 315. 410. 411.
Skarvefjeld. Gn. 122. 349. 356. 404. 406.
Slibestensfjeld. Um. 35. 160. 297. 314.
Smallesund. F. 107. 217. 225. 323.
Sorte Pynt. E. 206.
South Glacier. E. = Sydbræ.
South Kitsigsut, Jb, see Kitsigsut.
South Siorarssuit. Jb. 44. 53. 69. 110. 201. 205. 215. 219. 263. 375.
South Strømfjord see Søndre Strømfjord.
Spiralkløften. E. 64. 123.
Steensby's Bjerg. E. 360. 402. 406. 441.
Statenhuk = Kap Farvel.
Store Qarajaq Isbræ. Um. 282.
Storøen. Jb. 12. 14.
Storøen. Um. 32. 34. 49. 111. 176. 232. 266.
Strindberg's Land. E. 64.
Suilaussaq. C. 105. 368.
Sukaussat. Up. 313. 356. 418.
Sukkertoppen. S. 117. 192. 394.
Sungaussaq. Eg. 36. 57. 165. 176. 334. 369.
Súngoq. H. 36. 270. 328. 333. 334.
Suputoq. H. 36.
Svartenhuk. Um. 134. 141. 240. 401.
Svartenhuk. Up. 403.
Sydbay. H. 394.
Sydbræ. E. 318. 422.
Søndre Næs. Up. 33.
Søndre Strømfjord. S. 167. 197. 322.

Tarajornitsoq. Gn. 122. 169.
Tarajungitsoq. Gn. 317. 342. 349. 352. 401. 405. 412. 415.
Tasermiut Qingua. Jb. 139.
Tasitsat. S. 225.
Tasiussaq. Eg. 328.
Tasiussârssuaq. S. 105.
Tâterât. E. 210.
Tayler's Havn. F. 44. 151.
The Biological Station. Gn. 203.
Tigssaluk. F. 187. 276.
Tingmiarmiut. E. 211.
Tiniteqilaq. E. 38. 147.
Tinuteqasaq. Eg. 370.
Tobiasdal. E. 153.
Traill Ø. E. 151.
Tuapagssuit. Gn. 414. 421.
Tuapagssuit. Um. 397. 403. 413. 419.
Tuapatsiait. F. 128. 145. 388. 390.
Tuapaussat. R. 315. 397. 420.
Tugtup Agtakôrfia. Jb. 44. 183. 227. 228. 241. 256. 391. 400.
Tulugartalik. Eg. 116.
Tuluvartalik. Jb. 218.
Tunorssuaq. Um. 169. 413.
Tunua. E. 258.
Tunugdliarfik. Jb. 174. 248. 294. 307. 391.
Tunusua. Gn. 407.
Tuperssuatsiaq. Jb. 228. 256. 307. 317.
Tuperssuartâ (Tuperssuartait). Um. 142. 314. 350.
Turner Sund. E. 120. 153. 360. 417.

Turner Ø. E. 147. 401. 402. 405. 408. 417.
Turritella Kløft. Um. 167.
Tvekegledal. E. 154. 155. 164.

Ubekendt Ejland. Um. 232. 285.
Uglehøjen. E. 423.
Uigordlerssuaq. Up. 33. 259. 276. 285. 383.
Uivfaq. Gn. 21. 28. 30. 35. 42. 50. 51. 60. 100. 104. 107. 134. 275. 346. 387. 405.
Ujaragssuaq. Gb. 288. 322.
Ujaragssuit. E. 150.
Ujaragssuit. R. 144. 315. 357. 413. 420. 423.
Ujaragsugssuk. R. 126. 427.
Ujaragtarfik. Eg. 61.
Ujaragtarfik. Jb. 63.
Ujaragtôrssuaq. Um. 350. 397. 403.
Umanak. Um. 45. 266. 277. 280.
Ũmánârssuk. Eg. 57.
Ũmánârssuk. H. 197.
Ũmánâtsiaq. Um. 49. 60. 203. 301. 343.
Ũmiamáko. Um. 285.
Umivik. Um. 134. 141. 401. 406.
Ũnartoq. Gn. 412. 415. 422.
Ũnartoq. Jb. 126.
Ũnartoq. R. 404. 414.
Ũnartoq Qingua. Jb. 325.
Ũnartorssuaq. Gn. 358. 401. 411. 414. 421. 424.
Ũnatuarssuk. R. 427.
Ũngôriarfik. H. 101. 150. 185. 333.
Upernaviarssuk. Up. 64. 65. 276. 367.
Upernavik. S. 361.
Upernavik. Up. 266. 276. 280. 285.
Upernavik Næs. Gn. 334. 367.
Utorqaq. H. 36.
Uvdlorssiutit. E. 325.
Uvkusigssat. Um. 283. 285. 320.
Uvkusik. Jb. 132. 258.

Vester Ejland. Eg. 105. 233.
Vesterfjeld. Um. 121. 313.
Vestfjord. E. 51.
Vimmelskaftet. E. 99. 155.
Vimmelskaftshus. E. 164.

Wegeners Halvø. E. 14. 47. 53. 99. 154. 155. 164. 184.
Wilcox Head. T. 195.
Wollaston Forland. E. 165.

Østerfjeld. Um. 35. 296.

ALPHABETICAL LIST OF THE MINERALS

Actinolite 285
Ægirine 270
Ænigmatite 307
Albite 378
Allanite 206
Aluminite 172
Analcite 356
Anatase 129
Ancylite 160
Andalusite 188
Andesine 384
Anhydrite 163
Ankerite 152
Annabergite 183
Anorthite 386
Anthophyllite 301
Apatite 175
Apophyllite 313
Aragonite 152
Avfvedsonite 290
Arksutite 84
Arsenopyrite 60
Asbestus 306
Ashcroftine 410
Astrophyllite 238
Atacamite 98
Augite 275
Azurite 154

Barite 163
Barkevikite 298
Beryl 257
Biotite 333
Bismuth 32
Bismuthinite 54
Bornite 39
Bravoite 59
Britholite 179
Brucite 133
Bunsenite 99

Calamine 237
Calcite 140
Cancrinite 388
Cappelenite 231
Carphosiderite 165
Cassiterite 127
Catapleiite 251
Cerussite 154
Chabazite 418
Chalcedony 120
Chalcocite 39
Chalcolamprite 113
Chalcopyrite 45
Chiolite 84
Chlorite 341
Chondrodite 188
Chromite 103
Chrysocolla 253
Cohenite 30
Columbite 129
Copiapite 173
Copper 12
Cordylite 158
Corundum 107
Cosalite 55
Covellite 54
Crocidolite 294
Cryolite 74
Cryolithionite 73
Cummingtonite 281
Cuprite 99
Cyanite 189

Dahllite 180
Diaspore 134
Diopside 266
Dolomite 149
Dumortierite 265

Elpidite 243
Endeiolite 113
Enstatite 276
Epididymite 310
Epidote 202
Epistolite 226
Epsomite 167
Erikite 212
Erythrine 183
Eucolite 246
Eudialyte 245
Eudidymite 309
Euxenite 131

Fergusonite 132
Fibroferrite 172
Fluorite 64

Gadolinite 395
Galena 52
Garnet 194
Gearksutite 89
Gedrite 305
Gieseckite 331
Glauconite 341
Goethite 134
Gold 13
Graphite 38
Gypsum 168
Gyrolite 349

Hagemannite 97
Halite 64
Hematite 108
Heulandite 411
Hexahydrite 167
Hisingerite 346
Hornblende 299
Hydronephelite 396
Hypersthene 280

Igalikite 256
Ilmenite 110

Ilvaite 214
Iolite 259
Iron 14
Iron-Richterite 282
Ivigtite 326

Jarlite 86

Kaersutite 296
Kaolin group 345
Kornerupine 230

Labradorite 385
Laumontite 408
Leifite 389
Lepidolite 339
Leucite 360
Leucophanite 311
Leucosphenite 264
Levynite 423
Limonite 134
Löllingite 60
Lorenzenite 223
Luzonite 48

Magnesite 136
Magnetite 104
Malachite 154
Marcasite 60
Mascagnite 162
Melanterite 167
Melilite 311
Mesolite 401
Metajarlite 86
Microcline 366
Microlite 112
Millerite 51
Mirabilite 168
Molybdenite 61
Monazite 175
Mordenite 409
Muscovite 327

Narsarsukite 318
Natrolite 397
Naujakasite 347
Nepheline 354
Nephrite 288
Neptunite 254

Okenite 348
Oligoclase 383
Olivine 185
Opal 123
Orthoclase 361

Pachnolite 91
Paragonite 326
Parisite 155
Pectolite 240
Pentlandite 42
Peristerite 382
Perovskite 112
Phillipsrite 418
Phlogopite 332
Phosphorite 181
Pickeringite 168
Platinum 14
Polylithionite 336
Prehnite 262
Prosopite 72
Ptilolite 409
Pyrite 55
Pyrochlore 112
Pyrolusite 129
Pyromorphite 182
Pyrrhotite 48

Quartz 114

Ralstonite 70
Ramsayite 223
Retinite 427
Reyerite 353
Rhabdite 31
Rhodochrosite 140
Rhodonite 239
Riebeckite 288
Rinkite 220
Rosenbuschite 220
Rutile 127

Sapphirine 192
Scapolite 393
Scolecite 406
Scorodite 182
Schizolite 241
Schreibersite 31
Seladonite 341
Serpentine 343
Siderite 136
Sillimanite 265
Silver 12
Smaltite 63
Sodalite 389
Soda-microcline 378
Soda-orthoclase 365
Sphalerite 43
Spinel 99
Spodiophyllite 339
Stannite 47
Staurolite 191
Steenstrupine 227
Stillbite 413
Sulphur 32
Synchysite 155

Tæniolite 340
Talc 319
Tetrahedrite 48
Thenardite 162
Thomsenolite 94
Thomsonite 402
Titanite 224
Topaz 189
Tourmaline 231
Tremolite 283
Troilite 48
Trona 160
Tschermigite 168

Ussingite 396

Valleriite 54
Vesuvianite 261
Vivianite 182

Wavellite 183
Weberite 88
Whewellite 426
Willemite 184
Wolframite 173
Wollastonite 239
Wulfenite 174

Yttriumapatite 178
Yttrotantalite 133
Yttrotitanite 226

Zaratite 160
Zircon 216
Zoisite 211

ADDENDA AND CORRIGENDA

Since the manuscript of the present work went to print (1948) a few new mineral occurrences have been discovered and a few new treatises on the subject published. These are recorded in the following, together with a few disturbing misprints.

Page 12. After the copper from Disko Fjord insert: East Greenland. In Gauss Halvø the Three Years Expedition in 1931 to 1934 found a plate of metallic copper in a fissure in Devonian sandstone at Wimann Bjerg. The thickness of the plate almost one mm, the form is exceedingly irregular, the largest dimension is ca. 20 cm, and the weight is 136 gm. There are no other minerals in connection with the copper than small masses of malachite. A spectrographical analysis, undertaken in the laboratory of dr. Poul Bergsøe, gave the following result: 0.11 Ag, 0.008 Bi and 0.2 As; of Ni and Pb were scarcely over 0.005, and Fe, Sn, Cd, Zn, and Au could not be demonstrated.

Page 36, line 3 from the top, unable read: able.

Page 45. Sphalerite. Immediately in front of "Chalcopyrite" insert: East Greenland: Mestersvig, see below.

Page 54. Galena. Immediately in front of "Covellite" insert: Mestersvig in Kong Oscar's Fjord. In 1948 Lauge Koch's Expedition found, as it seems, very rich lead and zinc occurrences. At the present time no detailed description of this occurrence exists with the exception of a few quite small notes in "The Polar Record", 6, No. 41, 1951, pp. 104—5 and No. 43, 1952, p. 378, and furthermore Bøgvad in Grønlandsbogen 2, p. 118. The most detailed information is given by P. Kampmann in "Indstilling vedrørende Udnyttelse af Mineralforekomsterne ved Mestersvig, Østgrønland". 1951. ("Proposal regarding the exploitation of the mineral occurrences at Mestersvig, East Greenland".) At that time detailed investigations were only at hand regarding a single occurrence called Blyklippen (The Lead Rock), where it has been possible to establish a mass of ore amounting to 400 000 tons and containing about 16.93 per cent lead and 7.83 per cent zinc. Ore having been found in several places within a larger area, it is possible that continued investigations may lead to essentially greater values.

Page 59, line 14 from the top, 1914 read: 1944.

Page 79, line 7 from below: geararksute read: gearksutite.

Page 82. Before Line 13 from below insert: Through exact examination newly undertaken in the area it is found that the total amount still left to be worked (1952) amounts to ca. 5-600 000 tons.

Page 86. Jarlite-Metajarlite. The correctness of the formula recorded for these minerals has been contested by BROSSET: Elektrokemisk och Röntgenkristallografisk Undersökning av komplexa Aluminiumfluorider. Diss. Stockholm 1942, and FERGUSON: Amer. Mineralogist. 34. 1949, p. 391. BØGVAD (Medd. D. Geol. Foren. 12, 1951, p. 109) communicates that according to recent chemical investigations by A. H. NIELSEN the formula undoubtedly is: $NaSr_2Al_2(F, OH)_{11}$.

Page 98. Upmost is inserted: A new mineral from Ivigtut. As a provisorical communication in Medd. D. Geol. Forening, 1951, p. 109 BØGVAD states that he has found a new mineral at the boundary between the cryolite and the surrounding greisen. The composition is $Na_2Sr_2Al_2(PO_4)F_9$ according to an analysis by H. A. NIELSEN. The mineral is monoclinic (or triclinic) with twinning lamellae. H. 4—5, sp. g. 3.66, colour flesh-red.

Page 102. In front of Godthaab district insert: Sukkertoppen district. As to the presence of spinel in the sapphirine occurrence at Sukkertoppen see RAMBERG. M. o. G. 142, No. 5. 1948, p. 15.

Page 104. Magnetite, before the Upernavik district insert: The Thule district see below.

Page 108. In continuation of the mention of the hematite from Kap York insert: In some places in the region of K. Y. ROSENKRANTZ and SKOU in 1952 observed large masses of iron ores. One locality is situated north of Bushnan Ø, close to the finding places of the large iron meteorites (p. 14); the other place is situated near a fjord, Parker Snow Bugt between Kap York and Thule. The ores are hematite and magnetite, the structure is fine-grained, sometimes almost microcrystalline; most samples contain quartz. The percentage of iron is mostly 35-40.

Page 113, line 1 from below, develope read: developed.

Page 117, line 11 from below, witdh read: width.

Page 121. In front of Niaqornârssuk insert: Niaqornat (ROSENKRANTZ 1949). Stalactites about 1—5 mm thick, all but parallel, though with rather an irregular course. Of particular interest are the intercalations of opal, 0.01—0.02 mm thick, which in thin sections appear as regular circles.

Page 123, line 14 from above. At the fortress at Kap Brewster H. P. PETERSEN in 1951 collected a number of specimens of brown opaque jasper, and furthermore a geode, partly filled with grey semitransparent chalcedony, and on Gaaseland, the point at Danmarks

Ø, specimens of black jasper; finally he has also collected specimens of stalactites in Milne Land on a rock behind Danmarks Ø, these specimens consisting of c. as much as about 25 mm thick, as well as a piece of basalt with separation of c. and opal in regular even layers.

Page 126, line 6 from below. Before Carlshavn insert: As to coalescenses of opal with chalcedony see above under Niaqornat and Milne Land.

Page 139. In front of "Ika" insert: At Ivigtut Bøgvad (Medd. D. Geol. Foren. 12, 1951, p. 110) reports having found spherulites of siderite (up to 20 mm); they sometimes contain a little fluorite and can be enclosed in green potassium-mica.

Page 157, line 2 from the top, concentrice read: concentrical.

Page 163, line 8 from the top, $CaSo_4$ read: $CaSO_4$.

Page 163. In front of Barite insert: Bøgvad (Medd. D. Geol. Foren. 12, 1951, p. 110) reports that baryto-celestite is to be found at Ivigtut.

Page 164. Before "Kongeborgen" insert: At Ravnefjeld in Wegener Halvø Noe-Nygaard in 1931 collected cleavage-pieces of barite with dimensions of until 6 cm.

Page 167, line 19 from below, p. 230 read: p. 50.

Page 167, line 17 from below, ferro- read: ferri-.

Page 173. In front of East Greenland insert: Umanak district, Kaniorqat. In this place Mona Hansen in 1951 collected small pieces of copiapite in crusty masses, the surface of which is provided with small warty projections (2—4 mm) with a smooth surface. The colour vividly yellow.

Page 186. As to the olivine from Siorarssuit see Bøgvad (Medd. D. Geol. Foren. 12, 1951, p. 58 and Henning Sørensen ibid. p. 62).

Page 192. As to the sapphirine at Sukkertoppen see treatise by Ramberg in M. o. G. 142, No. 5, 1948, p. 16.

Page 193. New investigations of the sapphirine from Fiskenæsset have been undertaken by Th. Vogt, published in Bull. Commiss. Géol. de Finlande 190, 1947, p. 15.

Page 232. In front of "Ubekendt Ejland" insert: Slightly north of Umivik in Svartenhuk Rosenkrantz in 1947 found tourmaline crystals in pegmatite; the crystals are bent and broken with badly developed faces (*m* and *a*). The pleochroism very strong: dark greyish-blue to light brownish.

Page 249, line 11 from below, three read: four, and some read: three.

Page 249, line 10 from below, some read: one.

Page 265. After the description of the sillimanite from Akugdleq in the Holsteinsborg district insert: Another occurrence of s. in the H.

district is given in the "Krystallografi og Mineralogi" by CLAUSEN and NOE-NYGAARD 1948, where there is stated that the s. occurs together with graphite at Utoqat (Utorqat?) in the Holsteinsborg district.

Page 266, line 18 from the top, malakonite read: malakolite.

Page 270, line 15 from the top, dm read: cm.

Page 270, line 18 from the top, heulandite read: hornblende.

Page 272, Line 11 from below, aggrees read: agrees.

Page 278. In front of Godthaab district insert: Sukkertoppen district. Sukkertoppen. As to the occurrence of broncite in this locality together with sapphirine see: RAMBERG, M. o. G. 142, No. 5, 1948, p. 15.

Page 300. After Siorarssuit insert: Sukkertoppen; as above.

Page 314. In front of Angnertuneq insert: East of Ikorfat ROSENKRANTZ has found a geode with numerous well-developed cubical crystals with small octahedron faces; the colour whitish.

Page 314. In front of Hareø insert: In the interior of Nugssuaq three characteristic occurrences of apophyllite have been found, all consisting of columnar aggregates. The one was found by KR. SKOU at Qapiartoq kitdleq and consists of particularly regular columns, whereas the other one which was found by ROSENKRANTZ in Agatdalen is distinguished by a fine rosy colour. The third occurrence is situated at Ilugissaq at Auvfarssuak where ROSENKRANTZ in 1952 found apophyllite in fine columnar aggregates; the large (up to 5 cm) cleavage-faces are in a very regular manner spherically curved; the colour is pure white.

Page 320, line 10 from the top, Uvkugissat read: Uvkusigsat.

Page 333. In front of Godthaab district insert: Sukkertoppen district. As to phlogopite from Sukkertoppen see: RAMBERG, M. o. G. 142, No. 5, 1948, p. 16.

Page 346. In front of Hisingerite insert: Gunnbjarnite, a new mineral, the composition of which can most nearly be characterized as: $6SiO, (Fe, Al)_2O_3 . 3 (Mg, Fe, Mn, Ca) O . 3 H_2O$ and rather related to the minerals of the nontronite-group. The mineral was found in 1946 by dr. EIGIL NIELSEN in Steensby's Bjerg at Hold with Hope in East-Greenland. As to further details see BØGGILD, M. o. G. 142, No. 8, 1951, p. 3.

Page 348. In front of Ritenbenk district insert: Umanak district. At Niaqornarssuk ROSENKRANTZ has collected small pebbles, geodes, the inside of which was made up of gyrolite, the outside of okenite.

Page 366. The soda-orthoclase from Narssârssuk has been analyzed by FREDRIKKE DONS with the following result as mean of two analyses

(private communication): SiO_2 63.48, Al_2O_3 22.26 (incl. TiO_2, Fe_2O_3, FeO, MnO), MgO tr., CaO 1.16, Na_2O 7.71, K_2O 4.56, H_2O 0.24 = 99.41. These values correspond to the formula Or 26.4, An 5.7, Ab 67.9.

Page 402. In front of East-Greenland insert: Stordalen in Nordfjord (ROSENKRANTZ 1948). Irregular fibrous masses; a single cavity with freely developed crystals (up to 1 cm in length). At the head of Nordfjord mesolite has been found together with stilbite.

Page 427. In front of Hare Øen insert: In Agatdalen ROSENKRANTZ has found a single rounded mass (about 1 cm) of retinite with strata of *Inoceramus* and leaves from lower Senonium.

Færdig fra trykkeriet den 9. februar 1953.

GRØNLAND

MEDD. OM GRØNL. BD. 149, NR. 3. [O. B. BØGGILD]



L591

Geodætisk Institut. København 1952
Copyright