Norbergite and Fluoborite, two new minerals from the Norberg mining district.

(Preliminary report.)

By

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In the course of geological studies in the iron-mining district of Norberg, in Central Sweden, I have encountered certain mineral associations of so much interest that a special study of them had to be undertaken. Several circumstances having delayed the completion of this work, I give here a summary of the data now available on two new minerals. The final report, to be published in the year-book of the Geological Survey, will give a full account of the properties of these minerals and of those associated with them, of the methods employed in the study, etc.

Norbergite. Only in massive aggregates, crystal system unknown. Colour pink (with a purplish tinge) to whitish. Hardness $6^1/_2$. Spec. gravity = 3.13—3.15. Optically biaxial, positive, with $2\,E = 82^\circ$ (measured, drawing-table method) which, with $\beta = 1.567$ gives $2\,V = 49^\circ\,30'$. Refractive indices $\alpha = 1.563$, $\gamma = 1.590$ (immersion method), $\beta = 1.567$ (from determinations of α and $\beta - \alpha$). Chemical properties (determined by Dr. A. BYGDÉN, of the Geological Survey): soluble in warm HCl, with segregation of silica; quantitative analysis shows it to be a magnesia silicate with fluorine (13.70 %) and water, corresponding to the formula $Mg_2\,SiO_4 \cdot Mg\,(F,OH)_2$.

This formula has been attributed to the (never analyzed) so-called prolectite from Nordmarken,[1] but, as shown in another paper in this number, the two minerals are very clearly different, and the existence of the Nordmarken prolectite as a mineral species distinct from the previously known humite minerals is highly dubious.

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[1] HJ. SJÖGREN, Contrib. to Swedish Mineralogy, no. 19. Bull. Geol. Inst. Upsala, Vol. II, p. 99.

Locality: Östanmossa iron mine, Norberg. Associated with tremolite and a peculiar variety of orthite (to be described later), replacing a dolomitic limestone. Chondrodite is abundant in other parts of the same mine. The norbergite is rare, as yet found only as a lump of less than a fist's size, and one much smaller specimen.

The proposed name is derived from the name of the district, since that of the mine is unsuitable for an international nomenclature.

Fluoborite. Hexagonal prisms without measurable end faces. Colourless. Hardness below 5, and probably about 3½. Spec. gravity at 15° = 2.89. Optically uniaxial, negative, with $\omega = 1.566$, $\varepsilon = 1.528$ (immersion method). Chemical properties (determined by Dr. A. BYGDÉN): soluble in H_2SO_4, gives strong reaction for fluorine, and boron flame; a preliminary quantitative analysis shows the mineral to be a magnesia borate with high percentages of fluorine and water, probably in the form of a combination of a magnesia borate and the group $Mg(F,OH)_2$. It is hoped that further work on the material at hand will make it possible to establish a definite formula.

Locality: Tallgruvan mine, E of Kallmora, Norberg. Associated minerals: magnetite, ludwigite,[1] chondrodite, some szabelyite (?), and their alteration products, the whole aggregate replacing a dolomite. The fluoborite is fairly common in this aggregate, and has been one of the first minerals to form.

The proposed name is derived from the unusual chemical character of the mineral.

The fluoborite is probably identical with a mineral from a ludwigite and szabelyite association in Lincoln County, Nevada, recently mentioned by J. L. GILLSON and EARL V. SHANNON.[2] The mineral in question is reported as uniaxial, negative, with $\omega = 1.561$, $\varepsilon = 1.527$, thus with no other difference then a slightly lower ω value. The chemical data that may be traced from the analysis of szabelyite mixed with some quantity of the unknown mineral would rather indicate that the latter is a silicate, but it is more probable that the material analyzed contained also other impurities.

Geol. Survey of Sweden, Febr., 1926.

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[1] This is the first occurrence of ludwigite discovered in Sweden. The corresponding manganese compound, pinakiolite, was discovered at Långban.

[2] Szabelyite from Lincoln County, Nevada. American Mineralogist, 1925, p. 137.

Notes on the crystals described as »prolectite».

By

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In a notice in this number I have described as norbergite a new mineral, the chemical proportions of which correspond to the formula $Mg_2SiO_4 \cdot Mg(F,OH)_2$, This formula places the norbergite, in a chemical respect, as an end member in the humite group, the composition of the various members being:

Clinohumite . . . . $4\,Mg_2SiO_4 \cdot Mg(F,OH)_2$
Humite . . . . $3\,Mg_2SiO_4 \cdot Mg(F,OH)_2$
Chondrodite . . . . $2\,Mg_2SiO_4 \cdot Mg(F,OH)_2$
Norbergite . . . . $Mg_2SiO_4 \cdot Mg(F,OH)_2$.

Unfortunately, we do not know whether the norbergite belongs to the humite group also in its crystallographic properties. This question cannot be settled until measurable crystals are discovered, or the crystal structure investigated together with those of the humite minerals.

It is well known that there exists a remarkably simple proportion between the vertical crystallographic axes of clinohumite, humite, and chondrodite, the ratio being 9 : 7 : 5. From this fact, PENFIELD and HOWE[1] predicted the discovery of a mineral with the composition $Mg_2SiO_4 \cdot Mg(F,OH)_2$ and a *c* axis equal to $^3/_5$ of that of chondrodite.

In 1893, HJ. SJÖGREN,[2] when describing the occurrences of clinohumite, humite and chondrodite in the iron mines of Nordmarken, had briefly mentioned the occurrence of a couple of crystals that could not be identified with anyone of the species mentioned, and which he suspected to represent a new member of the humite

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[1] On the chemical composition of chondrodite, humite and clinohumite. Am. Journ. Science, 47, 1894, p. 188.

[2] Contrib. to Swedish Mineralogy. Bull. Geol. Inst. Upsala, Vol. I, p. 40.

group. In 1895, the same author[1] described the two fragmental crystals in question as prolectite. As further investigations had not given any new material, SJÖGREN had decided not to postpone any more the description of these peculiar crystals, although he admits that the material is »very imperfect». Each of the two crystals measured about 1 cm in diameter. »The faces were not very brilliant and only imperfectly fit for measurements.» The crystallographic measurements did not permit the identification of the mineral with any known member of the humite group, not even when reckoning with the possibility of twinning. SJÖGREN then tried an axial system with the c axis equal to $^3/_5$ of the corresponding axis in chondrodite. For the system adopted, $a:b:c = 1.0803:1:1.8862$, the goniometer readings could be interpreted into reasonable faces. However, as SJÖGREN himself states, »the differences between measured and calculated angles is pretty great, which may be due either to the unsatisfactory development of the faces or to the proposed axial ratio not being the true one».

The material was deemed insufficient for chemical analysis, and instead partly used for optical determinations. The angle between the plane of the optical axes and the supposed basal plane was found to be 44°—47°, the other Nordmarken minerals having: humite 0°0′, chondrodite 27°30′, clinohumite 12°—15°.

The acute axial angle was measured in a Thoulet's solution with an index of refraction for Na light = 1.6703, and found to be $2\,\mathrm{K}\,ay = 79°45'$. This, also, means a difference from the associated minerals, the chondrodite being the nearest with $2\,\mathrm{K}\,ay = 77°50'$. SJÖGREN now concluded that the mineral in question »is both geometrically and optically distinct from the other minerals of the humite group». From the supposed axial ratio, SJÖGREN deduced the formula $Mg_2SiO_4 \cdot Mg(F,OH)_2$. Prolectite should thus be the mineral of this composition, the discovery of which had been predicted by PENFIELD and HOWE.

It is necessary to emphasize that the above data are the only ones published by SJÖGREN on the prolectite. In several works of reference in optical mineralogy, other properties are also quoted, but this is clearly due to misunderstandings or mistakes.

When the composition of the norbergite turned out to be the one supposed by SJÖGREN for prolectite, it became necessary to obtain more data on the latter for a comparison of the two. Through the courtesy of Prof. G. AMINOFF, I have had the opportunity to

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[1] Contrib. to Swedish Mineralogy, no. 19. Bull. Geol. Inst. Upsala Vol. II, p. 99.

study optically SJÖGREN's material of the prolectite, now belonging to the Museum of Natural History in Stockholm. It turned out that one of the thin sections shows an aggregate of four differently orientated grains (uncertain whether twinning or not). The maximum difference in orientation is 17°. SJÖGREN always speaks of two crystals, both of which were measured. One is then forced to the conclusion that also this grain was used.

By the immersion method, I determined the medium refractive index $\beta = 1.639$. On the refractometer, the crystal from which the section was cut gave, for sodium light, $\alpha = 1.624$, $\beta = 1.638$. As it was desirable to obtain a further control on these values, Prof. AMINOFF, at my request, kindly undertook a determination with a monochromator, obtaining $\alpha_{Na} = 1.623$, $\beta_{Na} = 1.637$.

Let us now first compare the prolectite with the norbergite. The properties determined for both are:

	2 V	α	β
Prolectite	81°40′ (from 2 K *ay* and β)	1.623	1.637
Norbergite	49°30′ (from 2 E and β)	1.563	1.567

It is evident that these two minerals must represent different species. The fact that the prolectite might contain a somewhat higher proportion of FeO cannot account for the differences.

It is, furthermore, rather improbable that the crystals described as prolectite have the chemical composition supposed by SJÖGREN, as the large proportion of the $Mg(F,OH)_2$ group ought to lower the refraction considerably below that of the chondrodite. Instead, the prolectite shows practically the same refraction as the associated chondrodite. For this mineral, SJÖGREN reports $\beta = 1.659$, but the calculation of β from the figures of the optical axial angles — the only data available for SJÖGREN — instead gives $\beta = 1.638$, a fact that has already been pointed out by BRUGNATELLI.[1] I have made direct determinations on SJÖGREN's chondrodite material from Nordmarken (in the collections of the Museum of Natural History), and found on the refractometer, for sodium light, $\alpha = 1.619$, $\beta = 1.632$, $\gamma = 1.653$. If we compare the available optical data on prolectite and chondrodite from Nordmarken, we find

	2 V (from 2 K *ay* and β)	α	β	γ	$\wedge \alpha : a$
Prolectite . . .	81°40′	1.623	1.637	?	44°—47′
Chondrodite . .	80°5′	1.619	1.632[2]	1.653	27°30′

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[1] Über den Titanolivin der Umgebung von Chiesa in Val Malenco. Zeitschr. f. Kryst., 39, 1904 (foot-note on p. 218).

[2] This figure from the refractometer must be preferred to the 1.638 value calculated from the axial angles.

With the exception of the angle $\alpha : a$, which depends on the identification of the surfaces of the prolectite crystals, the differences are not greater than is often found among chondrodites from one single locality.[1] SJÖGREN's own words, cited above, make it clear that no decision can be based upon the goniometer measurements. It is, then, not improbable that the crystals described as prolectite belong to the species chondrodite.

In summary:

The mineral described by SJÖGREN as prolectite is very distinctly different from the one now described by the writer as norbergite.

The optical properties of the prolectite do not indicate the supposed composition $Mg_2SiO_4 \cdot Mg(F,OH)_2$.

The optical properties are so closely similar to those of the associated chondrodite that it is not improbable that the two minerals belong to the same species.

In any case, the name prolectite ought to disappear from the list of mineral species.

Geol. Survey of Sweden, Febr., 1926.

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[1] ESPER S. LARSEN, The microscopic determination of the nonopaque minerals. U. S. Geol. Survey, Bull. 679 (p. 57). HARRY VON ECKERMANN, The rocks and contact minerals of the Mansjö Mountain. G. F. F., 44, 1922 (p. 381).