7. Svabite a New Member of the Apatite Group. Pl. V, fig. 8—11.

1. Svabite from the Harstigen Mine.

Of late years an unknown mineral has several times been observed in massive granular pieces of schefferite from the Harstigen mine, Pajsberg, but always in such small quantities, that an examination was scarcely possible[1]. In the spring of 1891, Mr G. FLINK, of Stockholm, kindly sent me some of the above material.

The mineral occurs as small hexagonal prisms, one or two millimetres in length, in druses of massive, dark-brown schefferite, together with yellow garnet, manganophyllite, brandtite and sarkinite. Of these schefferite is evidently the oldest, next to which comes garnet, occasionally occurring as globular aggregates showing small faces of ∞O (011), whilst manganophyllite, the hydrous arseniates, sarkinite, brandtite and the new mineral named svabite constitute a third generation[2].

The crystals are white, colourless, transparent; lustre vitreous to resinous; streak colourless; H. 5; G. 3. 52; brittle. Before the blowpipe the mineral fuses slowly to a black slag; with soda on charcoal gives an arsenical odour. Soluble in diluted acids.

On the quantitative analysis, only 0.1390 grammes were expended.

Analysis IV.

Svabite from Harstigen (R. Mauzelius).

Gravity = 3.52 at + 18° C.

	%	Molecular-Ratio.		
Insoluble . . .	2.1	—	—	—
$As\,O_5$	52.2	0.227	0.227	3.
$Fe_2O_3 + P_2O_5$	0.9	—	—	—
Ca O	42.5	0.759	0.776	10.26
Mg O	0.7	0.07		
Pb O	trace	—	—	—
H_2O	1.0	0.056	0.058	0.78
Cl_2	0.1	0.002		
	99.5			

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[1] A. HAMBERG mentions a white, hexagonal arseniate occurring with lead, karyopylite, sarkinite and] brandtite. Probably the mineral I am here describing is one and the same, although HAMBERG denominates it an arseniate of lead and also adds that it occurs chiefly on and together with metallic lead. See Hamberg's "Ueber Krystallisirtes Blei von der Grube Harstigen bei Pajsberg in Wermland". Zeitschr. f. Krystallographie Bd. 17, s. 258, and "Om kristalliseradt bly från Harstigsgrufvan vid Pajsberg i Wermland", Öfversigt af K. Vetenskaps-Akad. Förhandl. 1888, s. 484.

[2] The relative ages of these minerals are also recorded by HAMBERG in his papers above mentioned.

The insoluble remainder was a brown powder, probably schefferite or garnet, occurring as impurities in the crystals. P_2O_5 and Fe were proved to be present but in such small quantities, that they could not be separated and determined, neither could Mn O and Sb_2O_5 be testified.

In a special experiment, carried out on a very small scale, the presence of Fl could be traced but not quantitatively determined and it is probable that the loss in the analysis of 0.5 per cent, was due to the presence of this component.

The above given molecular ratio, as deduced from the analysis, points to the formula

$$HO . Ca_5 As_3 O_{12}$$

$$\text{or} \quad 3 As_2O_5 . 10 CaO . H_2O$$

which evidently corresponds with that of apatite and can be derived from the latter if P_2O_5 is exchanged for As_2O_5 and Fl and Cl for HO. To show the close agreement with the formula, the analysis is calculated at 100, the insoluble impurities and the undetermined Fe_2O_3 and P_2O_5 being excluded. The small amounts of MgO and Cl_2 are reduced to quantivalents of CaO and H_2O, in order to facilitate comparison.

	As found.	Calculated.
As_2O_5	54.1	54.42
CaO	44.9	44.16
H_2O	1.0	1.42

The agreement is therefore satisfactory, being greater than the above figures show, because no attention, in this calculation, is paid to the amount of Fl, which is qualitatively, but not quantitatively determined.

If the loss in the analysis of 0.5 per cent is assumed to be Fl, the ratio of 0.78 is raised to 0.94 thereby agreeing closely with the formula which demands the value 1 for this ratio.

The chemical relation of the mineral to apatite is evident. Especially interesting is the occurrence of the hydroxyl-group HO, which is only partly replaced by Cl and Fl. This is, I believe, without analogy, in the apatite group. If, with GROTH, we deduce the formula of apatite from five molecules $Ca(OH)_2$ in which only nine (OH) have been replaced by three AsO_4, the tenth (OH) can either be substituted by Cl and Fl, as in apatite, or remain unreplaced in the formula, as is the case in question.

I think the occurrence of a mineral of this constitution must confirm the above mentioned view on the apatite formula.

Crystallographically also full agreement is found with apatite.

The crystals are of a prismatic type and belong to the hexagonal system.

The following forms are observed:

a[1] $= \infty P \; (10\bar{1}0)$
$x = P \; (10\bar{1}1)$
$v = P2 \; (11\bar{2}1)$
$c = oP \; (0001)$

The prism $a = \infty P$ predominates and gives the crystals their long prismatic form. The unit pyramid $x = P$ occurs on all crystals and the corresponding one of the second series $v = P2$ is also common. The basal plane when present is always small. Fig. 8, 9, Pl. V.

The measurements of two crystals are shown in the following table.

	Crystal I.	**Crystal II.**	**Calculated.**
$a : x$	50° 11′—42′ Average of 6 angles 50° 28′	50° 17′—51′ Average of 6 angles 50° 30′	50° 29′
$x : x$ (top)	Average of 3 angles 78° 46′	Average of 3 angles 78° 36′	79° 2′
$x : x$ (top-edge)		36° 10′	36° 20′
$x : v$		Average of 3 angles 17° 36′	18° 10′

The angles mark rather great differences; especially in the vertical zone as will be seen below.

The system of axes calculated from these angles is

$$a : c = 1 : 0.7143$$

To facilitate comparison I will also give the systems of axes of some of the minerals belonging to the apatite-group, viz:

Apatite . . . . $a : c = 1 : 0.7346$
Pyromorphite . . . $= 1 : 0.7362$
Mimetite . . . . . . $= 1 : 0.7276$
Vanadinite . . . . . $= 1 : 0.7122$

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[1] The letters are chosen to agree with the corresponding ones of apatite.

Thus the system of axes of svabite closely agrees with that of the other members of the apatite group. It would also be interesting to determine whether the svabite belongs to the pyramidal-hemihedral section or not, as is the case with apatite. But this cannot be decided, as dihexagonal pyramids and prisms are absent. But there really is a fact, which points to the conclusion that svabite is hemihedral, for by measurements in the vertical zone, one obtains for each prismatic plane, double images, i. e. beyond the ordinary plain image, there appears, at some distance from it, a second, duller one. It is worthy of notice, that these latter always lie on the same side of the main image. On crystal N:o 1, the measurement gave the following angles, which I have arranged by putting in the first line the main images, in the second the less clear secondary images and in the third the differences between each main image and the corresponding secondary one.

	I.	II.	III.	IV.	V.	VI.
Main images	0° 0′	60° 32′	122° 31′	182° 5′	242° 16′	302° 6′
Second. images		57 36	117 28	176 20		300 43
Differences		2 56	5 3	5 45		1 23

Thus, four among the six main images of the prismatic faces, are accompanied by secondary ones, all lying on the same side of the main.

In this fact we must probably see a case of hemihedral development and ascribe the secondary images to different prismatic planes of the third series.

The crystallographical examination is fully confirmed by the properties of the crystals as shown in parallel and convergent polarized light. A section cut parallel with a prismatic plane, marks extinction in the stauroscope rectangularly and parallel to the axis.

Cleavages parallel to ∞P are thereby noticeable. Another section cut vertical to the *c*.-axis, shows extinction in parallel polarized light during a complete revolution of 360°.

In convergent light the same section shows an uniaxial interference figure, viz: a broad, dark cross without any rings, owing to the weak double refraction. On turning, the cross slightly opens, showing a feeble aud anomalous biaxial character as is also sometimes the case with apatite. The double refraction is negative.

2. **Svabite from the Jakobsberg Mine.**

The same mineral was also met with, some time later, in the Jakobsberg Manganese Mine, near Nordmarken, where I found it in October 1891. The appearance of the mineral here is so unlike that at Harstigen that only by quantitative analysis can its identity with svabite be proved. The svabite from Jakobsberg is massive, yellowish white or quite colourless, translucent and of a vitreous to resinous lustre. No trace of crystalline form and no cleavage can be seen and the blowpipe characters are the same as those mentioned for the Harstigen mineral.

The mineral at Jakobsberg is enclosed in granular and crystalline hausmannite.

Mr R. MAUZELIUS has made two analyses of different varieties.

Analysis V.

Svabite from Jakobsberg (R. Mauzelius).

G = 3.77 at 16° C.

	%	Molecular-Ratio.		
As_2O_5	51.05	0.222	0.225	3.
P_2O_5	0.38	0.003		
SO_3	0,69	0.009	0.077	1.03
Cl_2	0.12	0.002		
Fl_2	1.99	0.052		
H_2O	0.25	0.014		
PbO	3.02	0.014	0.795	10.6
FeO	0.08	0,001		
MnO	0.26	0.004		
CaO	42.07	0.751		
MgO	0.52	0.013		
K_2O	0.30	0.003		
Na_2O	0.56	0.009		
	101.29			
$O = Fl_2, Cl_2$	0.87			
	100.42			

By dissolving the mineral in H Cl an insoluble remainder of 2.22 % was found which proved to be barite. The quantities of H_2O, Fl and Cl were each determined in different assays.

The molecular ratio shown above of 3 : 10.6 : 1.03 evidently corresponds with the formula

$$Fl\,Ca_5\,As_3\,O_{12}$$

$$\text{or}\quad 3\,As_2O_5 \,.\, 9\,CaO \,.\, CaFl_2$$

in which some Fl is replaced by Cl and H O, and Ca partly by Pb, Mg and alkalies.

In this formula we recognise that of apatite with P replaced by As.

Analysis VI,

Svabite from Jakobsberg (R. Mauzelius).
G = 3.82 at 15° C.

	%	Molecular-Ratio.		
As_2O_5	50.92		0.221	3.
P_2O_5	trace			
SO_3	0.57	0.007	0.100	1.36
Cl_2 . . , ...	0.08	0.001		
Fl_2	2.80	0.074		
H_2O	0.33	0.018		
PbO	4.52	0.020	0.796	10.8
FeO	0.14	0.002		
MnO	0.19	0.003		
CaO	37.22	0.665		
MgO	3.90	0.097		
K_2O	0.28	0.003		
Na_2O	0.39	0.006		
	101.34			
$O = Fl_2, Cl_2$ . .	1.20			
	100.14			

This analysis does not show as good agreement with the formula as the above, because the molecular ratio is 3 : 10.8 : 1.36 instead of 3 : 10 : 1, but I think it is most probable that the composition of this variety is alike[1].

Although in the latter, by dissolving the mineral, a small quantity of barite was discovered. A comparison with Analysis IV shows that in the Jakobsberg mineral Fl replaces, for the most part, HO, which circumstance still more increases the agreement in composition with apatite. Also in the mineral from Jakobsberg Pb, Mg, K and Na enter in larger amounts replacing Ca.

The differences in gravity are thus explained in the varying quantities of Pb, as the gravity is greatest (= 3.82) in the variety from Jakobsberg which contains most Pb (4.52 %) and smallest in the mineral from Harstigen with only traces of Pb.

Crystallized Svabite from Jakobsberg. Through MR G. FLINK, I received a specimen from the above locality, which he suggested was identical with the svabite from Harstigen about which I had just published

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[1] The molecular ratio, also written as 2 : 7.17 : 0.9 corresponds better with the formula $Ca_7 As_4 O_{16} Fl_2 = 2 Ca_3 As_2 O_8 + Ca Fl_2$.

a preliminary note. The specimen showed exceedingly small needle-shaped white crystals, at most 0.5 m.m. in length, implanted in small cavities in black, massive hausmannite. Under the microscope the crystals were found to be formed in the shape of hexagonal prisms $\infty P(10\bar{1}0)$ terminating only in the basal plane $oP(0001)$ (Fig. 10, Pl. V.), the prismatic faces were definitely striated in the direction of the axis. A section vertical to the axis shows an uniaxial image with negative character. Also a decided zone structure is observable (Fig. 11, Pl. V). A qualitative analysis of a very minute quantity of material proved As_2O_5 and CaO to be present and so the identity with svabite was regarded as fixed.

The Harstigen crystals allow of an accurate determination of their crystallographical form, while their constitution could not exactly be fixed, on account of the small quantity of material employed for the analysis. On the other hand, the mineral from Jakobsberg, which was not crystallized, allowed of a complete and exact determination of its chemical formula. So there can now be no doubt as to the constitution and systematical relations of the mineral.

The mineral is named after the eminent Swedish mineralogist and metallurgist of last century »Bergsråd» Anton SVAB.

Characters. Hexagonal, probably pyramidal hemihedral; $a : c = 1 : 0.7143$. Isomorphous with apatite etc. Cleavage ∞P, imperfect. In crystals of prismatic habit (Harstigen and Jakobsberg) and massive (Jakobsberg) $H = 5$. $G = 3.52$ (Harstigen) or 3.77 — 3.82 (Pb-bearing, Jakobsberg). Lustre vitreous to subresinous. Crystals colourless or white, massive yellowish white; streak white. Transparent or translucent. Fracture uneven and chonchoidal. Brittle. Composition $HO.Ca_5As_3O_{12} = 9CaO.3As_2O_5 + Ca(OH)_2$ with some P_2O_5 replacing As_2O_5 and PbO, MgO, MnO, FeO and alkalies replacing CaO; H and Cl also enter instead of (HO). Before the blowpipe fuses with difficulty to a black slag; gives with sodium on charcoal arsenical odour. Occurs in the Harstigen iron and manganese mine, in druses as small crystals on massive schefferite and garnet, together with brandtite, sarkinite and manganophyllite and massive or as very minute crystals in hausmannite in the manganese mine of Jakobsberg in Vermland.

8. Adelite a New Basic Arseniate from Nordmarken, Jakobsberg and Långban, Vermland[1]. Pl. V. Fig. 12, 13.

1. Adelite from the Kittel-mine. Nordmarken.

In the year 1887 or 1888 there was found in the Kittel-mine, Nordmarken, a grey, massive mineral occurring in considerable quantities, which, before the blowpipe, gave the reactions of berzeliite. Further in-

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[1] Part of this paper was already published as a preliminary note in Geol. Fören. Förhandl. Vol. 13, p. 781, 1891.