KUNGL. SVENSKA VETENSKAPSAKADEMIENS HANDLINGAR
TREDJE SERIEN. BAND 9. N:O 5.

CONTRIBUTIONS TO THE MINERALOGY OF LÅNGBAN

I—V

WITH 22 FIGURES IN THE TEXT

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V. Arsenoklasite, a new Arsenate from Långban.

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(With chemical analyses by R. BLIX.)

With 1 fig. in the text.

Mode of Occurrence. As a rule arsenoklasite occurs together with sarkinite in fissures in hausmannite-impregnated dolomite from the work-place »Ireland». The new mineral presents certain external similarities to sarkinite, but it can without difficulty be distinguished from this mineral by a far more pronounced cleavage than that exhibited by sarkinite. Generally, but not always, arsenoklasite has also a more brownish tinge of red than sarkinite. As regards the minerals that are associated with arsenoklasite, reference may be made to FLINK's description of sarkinite.[1] To these may, however, be added one more, viz. adelite. What is designated by FLINK as »nr. 245» (l.c. p. 663) has proved to be this hitherto but incompletely known mineral. Adelite seems always to occur in the specimens that contain arsenoklasite, while on the other hand sarkinite is not always accompanied by adelite. Adelite has crystallized earlier than arsenoklasite.

In the cases where arsenoklasite and sarkinite occur together in the same sample, it is possible to observe that they are separated by a sharp limit. The two minerals seem to have crystallized at the same time.

Chemical Composition. Fil. Kand. R. BLIX has carried out a quantitative analysis of the mineral, the result of which is given in Table 1.

Table 1.

		Mol. quot.	
As_2O_5	36,96	0,1607	
MnO	55,01	0,7755	0,8081
MgO	0,87	0,0216	
FeO	Traces		
BaO	0,11	0,0007	
CaO	0,57	0,0102	
H_2O	5,86	0,3258	
H_2O (Hygrosc.)	0,04		
	99,42		

[1] Geol. Fören. Förh. **46** (1924), pp. 662—663.

The molecular quotients are, thus:

$$As_2O_5 : \overset{II}{R}O : H_2O = 0{,}1607 : 0{,}8081 : 0{,}3253 = 1{,}00 : 5{,}03 : 2{,}02 .$$

Accordingly, the formula of the mineral can be written

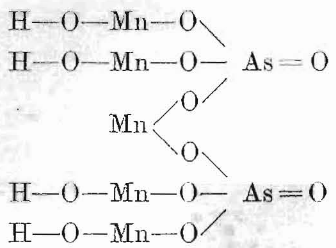
$$5\,\overset{II}{R}O \,.\, As_2O_5 \,.\, 2\,H_2O$$

or

$$\overset{II}{R}_3(AsO_4)_2 \,.\, 2\,\overset{II}{R}(OH)_2$$

where $\overset{II}{R} = \overset{II}{Mn}$, replaced by an inconsiderable quantity of Mg, Ca and Ba.

The structure formula of the mineral can be set down as follows:



As regards its chemical composition, the mineral occupies a mean position between sarkinite and allactite:

$Mn_3(AsO_4)_2 \,.\, Mn(OH)_2$ = sarkinite
$Mn_3(AsO_4)_2 \,.\, 2\,Mn(OH)_2$ = arsenoklasite
$Mn_3(AsO_4)_2 \,.\, 3\,Mn(OH)_2$ = unknown[1]
$Mn_3(AsO_4)_2 \,.\, 4\,Mn(OH)_2$ = allactite

Copper minerals with a composition analogous to arsenoklasite are:

$Cu_3(PO_4)_2 \,.\, 2\,Cu(OH)_2$ = dihydrite
$Cu_3(AsO_4)_2 \,.\, 2\,Cu(OH)_2$ = erinite
$Cu_3(VO_4)_2 \,.\, 2\,Cu(OH)_2$ = turanite

Chrystallographic Properties. Arsenoklasite does not occur in the form of crystals. With the aid of an occasionally occurring striation, however, it is possible to fix a crystallographic direction lying in the cleavage surface. Laue photographs, obtained when the X-ray beam is perpendicular to the cleavage surface, have two symmetry planes, one parallel to and the other perpendicular to the direction lying in the cleavage surface. The necessary conclusion from these observations is that the mineral has *rhombic symmetry*, which is confirmed by optic observations. Whether the symmetry of the mineral is lower than holohedral cannot be decided from the present material.

[1] The corresponding copper mineral is clinoklasite $Cu_3(AsO_4)_2 \,.\, 3\,Cu(OH)_2$.

For the determination of the dimensions of the elementary cells three rotation photographs were exposed and measured:

I. Rotation axis perpendicular to the cleavage surface:

Layer line	I	T_1 = 18,20 Å
» »	II	= 17,92
» »	III	= 17,93
» »	IV	= 18,01
» »	V	= 17,86
» »	VI	= 18,06
» »	VII	= 18,07
		Average T_1 = 18,01 Å

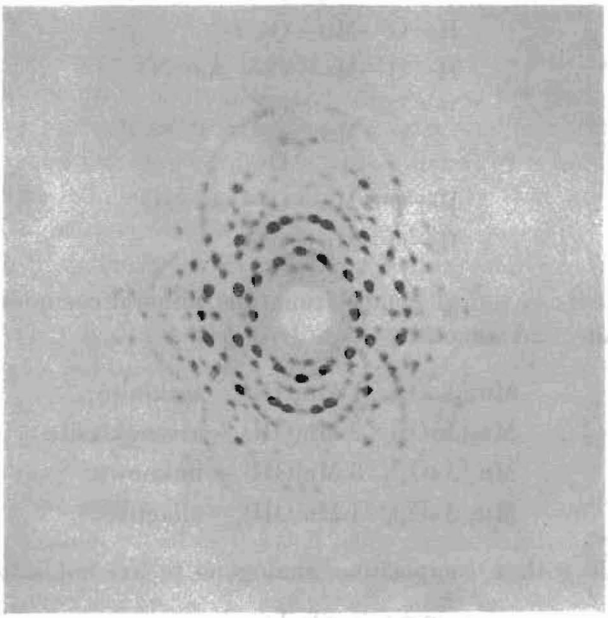


Fig. 1. Laue photograph of arsenoklasite on {010}.

II. Rotation axis lying in the cleavage surface and parallel to the striation:

Layer line	I	T_2 = 5,80 Å
» »	II	= 5,79
		Average T_2 = $5,79_5$ Å

III. Rotation axis in the cleavage surface and perpendicular to the striation:

Layer line	I	T_3 = 9,16 Å
» »	II	= 9,18
» »	III	= 9,23
		Average T_3 = 9,19 Å

Thus, if $T_1 = b$, $T_2 = c$ and $T_3 = a$, the axial ratio is

$$a : b : c = 9{,}19 : 18{,}01 : 5{,}79_5 = 0{,}510_2 : 1 : 0{,}312_8.$$

Thus in this orientation the cleavage surface is designated as $\{010\}$. The specific weight of the mineral is 4,161, and the number of molecules in the cell is thus calculated from the equation

$$9{,}19 \times 18{,}01 \times 5{,}79_5 \times 4{,}161 = N \times 618{,}3 \times 1{,}65$$

$$N = 3{,}91 \ (\sim 4)$$

The cell consequently contains 4 molecules $Mn_3(AsO_4)_2 \cdot 2\,Mn(OH)_2$. In order to determine whether the cell is body- or face-centred or not centred, indices were assigned to the Laue photograph. The index field was then studied in respect of the presence of reflections of the 1st order, where

h + k	= odd numbers	
k + l	= »	»
h + l	= »	»
h + k + l	= »	»

It proved that there occurred on the plate a majority of reflections deriving from planes of all these categories. Thus the cell is not centred, in other words the translation lattice is Γ_v.

Thus the space groups possible for arsenoklasite are

$$C_{2v}^{1-10},\ V^{1-4} \text{ and } V_h^{1-16}$$

In the Laue photograph appear reflections of 510 and 610 in the 1st order. In consequence of this, all groups must be excluded where prism reflections of the types $H + K \neq 2p$, $H \neq 2p$, and $K \neq 2p$ are forbidden. These are:

$$V_h^2,\ V_h^4,\ V_h^6,\ V_h^8,\ V_h^{10},\ V_h^{11},\ V^{13} \text{ and } V_h^{15}.$$

In the rotation photograph round [010] occur reflections of 013, 102 and 301. Consequently those groups must be excluded where OKL reflections of types $K \neq 2p$ and $L \neq 2p$ and HOL reflections of types $H + L \neq 2p$, $H \neq 2p$, and $L \neq 2p$ are forbidden. Thereby must further be excluded the groups:

$$V_h^3,\ V_h^5,\ V_h^7,\ V_h^9,\ V_h^{12},\ V_h^{14} \text{ and } V_h^{16}$$

$$C_{2v}^{2-6} \text{ and } C_{2v}^{8-10}.$$

Thus, of the groups which are compatible with the data of the X-ray photographs, there remain:

$$V_h^1,\ V^{1-4},\ C_{2v}^1 \text{ and } C_{2v}^7.$$

We have not been successful in excluding with full certainty any of these space groups. The absence of 300 and 500 in the presence of 400 and the absence of 030 seems to speak in favour of the groups V^3 or V^4. Nor has an attempt at determining the symmetry class led to definite results.

Of the possible space-groups only V_h^1 has 8-fold positions; in the others the highest number of equivalent points is 4. Thus only the As-ions could assume equivalent positions, and this only if the mineral is holohedral.

Optical Properties. Arsenoklasite is optically negative. The acute bisectrix is perpendicular to the cleavage surface, *i.e.* in the orientation here chosen, {010}. The axial plane is parallel to {100}. Consequently, $b = \alpha$, $a = \beta$, $c = \gamma$. The optical angle in air is determined in a plate parallel to {010}. (Cleavage piece.) The following values were obtained:

		2 E
$\lambda = 486{,}1\ \mu\mu$	(F)	102° 31′
$= 527{,}0$ »	(E)	105° 23′
$= 540{,}0$ »	—	106° 14′
$= 589{,}3$ »	(Na)	108° 57′
$= 656{,}3$ »	(C)	111° 19′.

In a prism[1] whose edge was parallel to [(100), (010)], and one of whose sides was parallel to {010} β and γ were determined. The following values were obtained for $\lambda = 589{,}3\ \mu\mu$

$$\beta = 1{,}810$$
$$\gamma = 1{,}816.$$

From $2\,E = 108°\ 57'$ and $\beta = 1{,}810$, for the same wave-length, was calculated

$$V = 26°\ 43'\ (\lambda = 589{,}3\ \mu\mu).$$

From the formula

$$tg\,V = \sqrt{\frac{\frac{1}{\alpha^2} - \frac{1}{\beta^2}}{\frac{1}{\beta^2} - \frac{1}{\gamma^2}}}$$

was then calculated $\alpha = 1{,}$~~800~~ 787. The value obtained for the axial angle in Na-light (108° 57′) shows good agreement with that (108° 45′) given in Flink's description of sarkinite (l.c., p. 667). As, according to Flink, the latter value (determined by E. Dahlström) refers to such sarkinite as shows marked cleavage, it readily suggests itself that Dahlström's measurements were effected on arsenoklasite and not on sarkinite, especially as the optical properties of this cleavage piece are not in agreement with those observed by Flink for sarkinite. Flink also indicates (l.c., p. 668) the possibility that the characteristics he ascribes to sarkinite actually refer to two different minerals, of which one is characterised by marked cleavage perpendicular to a negative acute bisectrix.

[1] $\alpha = 24°\ 15'$.

Characteristics of Arsenoklasite. Chemical formula: $Mn_3(AsO_4)_2 . 2\,Mn(OH)_2$. Orthorombic. $a = 9{,}19$ Å, $b = 18{,}01$ Å, $c = 5{,}79_5$ Å. $a : b : c = 0{,}510_2 : 1 : 0{,}312_8$. 4 molecules in the unit cell. Possible space groups: V_h^1, V^{1-4}, C_{2v}^1 and C_{2v}^7. Opt. neg. Acute bis. ⊥ {010}. Axial plane // {100}. $2\,E_{Na} = 108°\ 57'$. $\alpha = 1{,}$[illegible], $\beta = 1{,}810$, $\gamma = 1{,}816$ (Na). $V_{Na} = 26°\ 43'$. Spec. gravity = 4,16. Hardness 5—6. Colour red. Cleavage // {010} very good. The name is derived from αρσενικον = arsenic and κλαω = to split, break. H·7[illegible]7

Tryckt den 16 mars 1931.