Zinckenite and Wolfsbergite (Chalcostibite) from Wolfsberg in the Harz; and the Zinckenite Group.

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ALTHOUGH zinckenite and wolfsbergite are to be considered as isomorphous, it seems to be as rare a thing to find simple crystals of zinckenite as it is to find twinned crystals of wolfsbergite. In the following note simple and twinned crystals of the two minerals respectively are described.

For wolfsbergite twinning has not been previously recorded; and simple crystals of zinckenite have only been described by Kenngott,[1] although it is possible that much of the finely acicular zinckenite of various localities really consists of simple crystals, but, being unsuitable for measurement, cannot be definitely asserted to be such. The channelled hexagonal prisms of the Wolfsberg zinckenite were interpreted by G. Rose[2] as consisting of three interpenetrating crystals, as in aragonite; he gives a hypothetical figure of a simple crystal consisting of a rhombic prism, with an angle of 59°21′, and a macrodome. The crystals measured by Kenngott were acicular, and, adopting Rose's position, he gives the forms present as ∞O and $\infty O\breve{\infty}$, and the prism angle as 59°26′; he also mentions a large untwinned crystal with a single terminal face.

The specimen of wolfsbergite, on which a twin crystal has been noticed, shows several simple crystals, one of these measuring $3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{2}$ cm. The twin crystal consists of two tabular individuals with the trace of their plane of junction parallel to the striations on the basal plane; the twin plane, which is also the plane of combination, is therefore a macrodome. On the broken end of the twin no discontinuity between the two individuals could be detected, so that it is not a case of accidental

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[1] *Ber. Akad. Wien*, IX. 527, 1852.
[2] *Pogg. Ann.* VII. 91, 1826.

juxtaposition. The angle between the normals to the two basal planes, as measured from wax impressions, is about 62°; for the twin plane to be (102)[1] the calculated angle is 62°37′.

The zinckenite specimen to be described had, on account of the habit of the crystals, been labelled as wolfsbergite, but analysis showed it to contain lead, antimony and sulphur, while copper and arsenic were absent. The blade-shaped crystals, which are small and somewhat indistinct, form a confused cellular aggregate on the flat surface of a matrix of stibnite and an indistinctly fibrous mineral containing lead, antimony and sulphur; this in turn rests on quartz, on the opposite surface of which are matted fibres closely resembling the feather-ore variety of jamesonite. On the first-mentioned surface are also a few small radiated groups of acicular crystals very like the usual zinckenite of Wolfsberg in appearance. The blade-shaped crystals are deeply striated parallel to their length, and show a large plane (c) with narrow planes (ϵ) at the edges; terminations are usually absent, being seen on only one crystal as a bright rounding. Attempts were made to measure six crystals, but, as they gave an almost continuous band of images, the results are not very satisfactory. On one crystal the four angles $c\epsilon$ were determined as 30°, 31°, 29° and 30°. Another crystal gave $\epsilon\epsilon'$ as 57°, and others, for the same angle, various values between $55\frac{1}{2}$° and $57\frac{1}{2}$°. The mean value of $\epsilon\epsilon'$ may then be given as about 58°, which approaches to Rose's value of 59° 21′. On the second crystal a narrow plane at 90° from c was observed; and in some cases there seemed to be an imperfect cleavage parallel to this plane (*i.e.* a (100)). Placing the crystals in the position adopted by Dana[2] the forms present are then:—

$$c\ \{001\},\ a\ \{100\}^{3},\ \epsilon\ \{102\}$$

The first is new to zinckenite. To this short list of forms are to be added Rose's k {061}, and Luedecke's[4] b {010}.

The qualitative chemical composition, the angle of about 58°, and the absence of any distinct cleavage, make it probable that the above-described crystals are zinckenite, although it is not a matter of absolute certainty. There are several sulph-antimonites of lead, but unfortunately the

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[1] The position of the crystals is that of Groth, *Tab. Uebers. Min.*, 3rd. Ed. 1889, p. 28.

[2] *System of Mineralogy*, 6th Ed. 1892, p. 112.

[3] This form a {100} has been recorded by Kenngott (*loc. cit.*), but has been previously overlooked.

[4] *Die Minerale des Harzes*, Berlin, 1896, p. 123.

characters of some are imperfectly known; plagionite, meneghinite and geocronite have angles of 59°30′, 55°45′ and 60°16′ respectively, but possess cleavages, and in the case of plagionite the habit is totally distinct.

The only species that have been recorded from the Harz[1] are zinckenite, plagionite, jamesonite and boulangerite, all of which occur with wolfsbergite in the antimony mine, Jost-Christians-Zeche, near Wolfsberg.

The habit of these crystals of zinckenite being so similar to that of wolfsbergite, it would naturally follow that, in order to show the isomorphism between the two minerals, the crystals should be placed in similar positions, as has been done above; in which case they are flattened parallel to the basal plane, and elongated and striated parallel to the macro-axis. The new twin plane of wolfsbergite is then also the same as that given by Rose for zinckenite, namely ϵ (102). Beyond the usual presence or absence of twinning, the only important difference between the two minerals is the absence of any distinct cleavage in zinckenite. The somewhat abnormal form *k* {061} present on zinckenite is now seen to be also present on emplectite and wolfsbergite (guejarite)[2].

This position of the crystals has been adopted by Dana for zinckenite, sartorite and emplectite, and by Groth for sartorite, emplectite and wolfsbergite. In fact, for the purpose of showing the isomorphism of the group, the direction of elongation and striation of the zinckenite crystals has been made the macro-axis, the brachy-axis and the vertical axis by Dana, Goldschmidt[3] and Groth respectively; and a similar confusion has existed in the case of wolfsbergite. This has been due to the crystallography of these minerals being imperfectly known, and to the similarity of the angles in all three axial zones, as is shown in the following table of calculated angles—

	Zinckenite $PbS.Sb_2S_3$ (Rose).	Sartorite $PbS.As_2S_3$ (vom Rath)	Emplectite $Cu_2S.Bi_2S_3$ (Weisbach)	Wolfsbergite $Cu_2S.Sb_2S_3$ (Friedel for Guejarite)
001 : 102	29° 40½′	29° 51½′	*29° 56½′*	31° 18½′
001 : 101	*48 44*	48 57	*49 2½*	50 34½
001 : 011	*32 26*	31 45	*32 2*	32 31½
001 : 021	*51 48*	51 3½	51 2½	51 54
001 : 061	75 18	*74 55½*	75 5	75 21
100 : 110	*29 8*	*28 19*	*28 30*	*27 40*

[1] O. Luedecke, *loc. cit.*; E. Schulze, *Lithia Hercynica*, Leipzig, 1895.

[2] The probable identity of wolfsbergite and guejarite was pointed out in a paper read before this Society on April 14th, 1896 (see this volume, p. x.).

[3] *Index der Krystallformen der Mineralien*, 1891, III. p. 331.

The above angles are given in italics when the corresponding forms in the second column have not been observed on the particular mineral; (102) is the twin plane for wolfsbergite, but not an observed crystal face. The corresponding parameters are :—

	a		*b*		*c*
Zinckenite	0·5575	:	1	:	0·6353
Sartorite	0·5389	:	1	:	0·6188
Emplectite[1]	0·5430	:	1	:	0·6256
Wolfsbergite[2]	0·5242	:	1	:	0·6376

[1] Groth (*Tab. Uebers. Min.*, 3rd Edit.) calculates from Weisbach's measurements $a:b:c = 0·5385:1:0·6204$. The above are as given by Dana (*Min.*, 6th Edit.).

[2] Laspeyres gives for wolfsbergite—$a:b:c$=0·52830 : 1 : 0·62339 (*Zeits. f. Kryst.* XIX. 428, 1891).