

A recalculation of the analysis gives (1) the following molecular composition.

		Per cent
Acmite	$\text{Na}_2\text{O} \cdot \text{Fe}_2\text{O}_3 \cdot 4\text{SiO}_2$	62.82
Jadeite	$\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$	4.85
Wollastonite	$\text{CaSiO}_3$	10.67
Enstatite	$\text{MgSiO}_3$	9.80
Hypersthene	$(\text{Fe}, \text{Mn})\text{SiO}_3$	3.26
$(\text{Na}, \text{K})_2\text{O} \cdot \text{SiO}_2$		2.87
$\text{TiO}_2$		2.57
$\text{SiO}_2$		3.36
$\text{H}_2\text{O}$		.27
		<hr/> 100.47

On the basis of this recalculation the mineral is made up chiefly of acmite and diopside with some jadeite.

Some of the material contains minute patterns which have the appearance and structure of sagenite when examined under a high power objective. This pattern looks like a breakdown, representing a separation of rutile similar to that sometimes found in altered biotite. The  $\text{TiO}_2$  may then represent one component of a solid solution which is unstable not far below its temperature of formation. The action of later hydrothermal solutions, perhaps acting in a manner analogous to a catalytic agent, may have brought about the separation.

## LÖLLINGITE FROM FRANKLIN, NEW JERSEY

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Measureable crystals of the mineral löllingite have been so rarely found that a new occurrence seems worthy of record. The observations here presented are based on specimens found during 1926 in the orebody of the mine at Franklin in a drift of the 750 foot level north. The crystals are sparsely embedded in a white limestone of medium grain together with grains of a gray pyroxene and occasional dots of franklinite. The löllingite crystals are complete individuals, brilliant tin-white in color, ranging in size

from tiniest specks to a diameter of 3 mm. They break freely and cleanly from the matrix and the brilliance of their lustre marked them at once as suitable for crystallographic study. Several crystals were measured by the junior author and gave excellent readings and very accordant angles as recorded in table 1 below.

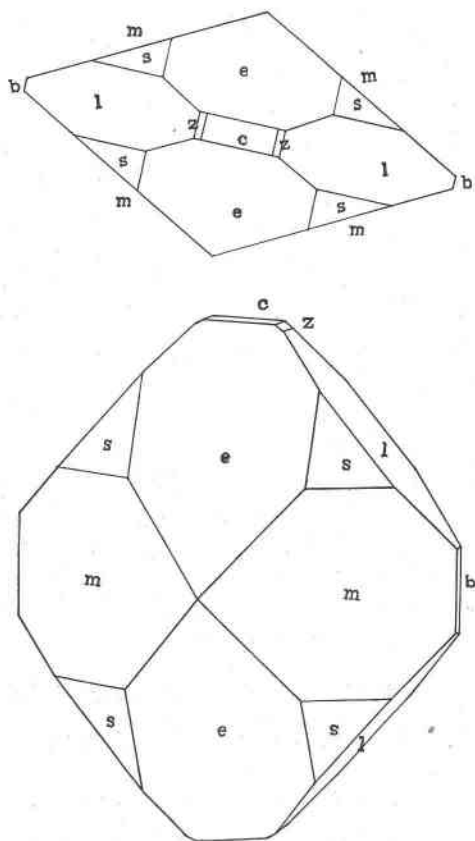


Fig. 1. Löllingite, Franklin, N. J.

These angles however differed so markedly from those previously recorded for löllingite that further measurements on the same and on other crystals were made by Professor Palache. These exactly confirmed Berman's results and served to emphasize the fine quality and extreme accordance of the angular values which these crystals present.

The habit of the crystals is variable; a few are prismatic parallel to the *a* axis, the brachydome giving almost a square cross-section, with small faces of prism and macrodome on the ends; some are equant with pseudocubic development, the isometric appearance heightened by numerous rounded surfaces between the brilliant faces of the three dominant forms. But the greater number are as shown in the figure, slightly flattened normal to the *a* axis and almost identical in development with the marcasite from Schemnitz shown in Dana, System, page 95, figure 2; or with only the forms *m*, *l*, and *e*, and striated parallel to the intersection edges of *m* and *e*.

TABLE 1. ANGLES OF LÖLLINGITE.

FORM	SYMBOL	MEASURED ANGLES		No. of FACES	QUAL.	CALCULATED ANGLES	
		$\varphi$	$\rho$			$\varphi$	$\rho$
<i>c</i>	(001)	0°00'	0°00'	1	poor	0°00'	0°00'
<i>b</i>	(010)	"	90 00	2	"	"	90 00
<i>m</i>	(110)	61 26 ± 2	"	8	excell.	61 27	"
<i>l</i>	(011)	0 00	48 29 ± 1	4	"	0 00	48 30
<i>s</i>	(012)	"	29 20 ± 6	2	poor	"	29 28
<i>e</i>	(101)	90 00	64 17½ ± 1½	4	excell.	90 00	64 18
<i>r</i>	(111)	61 29 ± 3	67 07 ± 1	3	fair	61 27	67 05

The dominant forms on the two measured crystals are *m*, *l*, and *e*. Their position angles as shown above scarcely vary as much as two minutes from crystal to crystal, a most unusual degree of accordance for crystals of any substance. The pyramid, *r*, is less constant in its quality and the other forms are negligible in development and quality. The elements were calculated from 19 faces of the forms noted, particular weight being given the prism faces in averaging the results. These elements, from which were calculated the angles given in table 1, are given below together with those hitherto accepted for löllingite and those of other members of the marcasite group.

TABLE 2. CRYSTALLOGRAPHIC ELEMENTS

	<i>a</i> : <i>b</i> : <i>c</i>	<i>p</i> <sub>0</sub>	<i>q</i> <sub>0</sub>
Löllingite, Franklin	0.5438 : 1 : 1.130	2.078	1.130
Löllingite, Norway, Brögger	0.6689 : 1 : 1.233	1.843	1.233
Arsenopyrite, Hohenstein, Dana	0.6773 : 1 : 1.188	1.754	1.188
Arsenopyrite, Franklin	0.6702 : 1 : 1.189	1.775	1.189
Marcasite, average, Goldschmidt	0.7580 : 1 : 1.212	1.599	1.212

It is evident from a consideration of table 2 that the marcasite group is not characterized by close accordance of the crystallographic elements of its members. The new values for the Franklin löllingite are very different from the only elements hitherto published, namely those given by Brögger for the löllingite of Norway which are commonly accepted. Reference to Brögger's description of his measured crystals leaves, however, no doubt that they were ill adapted for accurate measurement. The new elements appear to be established. It may be noted that the elements of arsenopyrite are intermediate to those of marcasite and löllingite, as newly established, a relation which seems reasonably to be expected. Since the arsenopyrite elements are subject to wide variation in crystals from different localities, a calculation was made of the elements of the slightly cobaltiferous arsenopyrite from Franklin, an analysis of which was published<sup>1</sup> in 1910 together with new forms found on the crystals. These were of the finest quality. The elements, calculated from measurements of 30 faces of the forms *m*, *l*, *e*, and *s* on 6 crystals are shown in table 2 and agree closely with those used in Dana's System.

In table 3 there is shown for the three minerals under consideration the variation of the angles of three important forms corresponding to the variation of the elements. The figures there given for löllingite crystals from Trotter Mine, Franklin, were made on poor crystals but are of interest because of their agreement with the angles calculated from the elements of the new crystals.

TABLE 3. VARIATION OF ANGLES

	010 to 110 = $\varphi$ of <i>m</i>	001 to 011 = $\rho$ of <i>l</i>	001 to 101 = $\rho$ of <i>e</i>
Löllingite, Franklin	61°27'	48°30'	64°18'
Löllingite, Trotter Mine	60 58	48 39	63 46
Arsenopyrite, Hohenstein, Dana	55 54	49 55	60 19
Arsenopyrite, Franklin	56 10	49 56	60 38
Marcasite, Dana	52 33	50 59	58 10

A chemical analysis of the Franklin löllingite was made by the senior author, using 0.4 grams of carefully selected crystals, with the following result.

<sup>1</sup> C. Palache. Contributions to the Mineralogy of Franklin Furnace. *Am. Jour. Sci.*, 29, 177 (1910).

	PER CENT	MOLECULAR RATIOS	
As	69.80	.933	} 1.78
S	0.21	.007	
Fe	29.40	.530	1
	<hr/> 99.41		

The slight deficiency of the analysis is due to the presence of calcite in small amount which was not determined. Sulphur is practically absent. There is insufficient arsenic, as shown by the molecular ratios, to yield exactly the 2 : 1 ratio of löllingite. Such a deficiency is common in analyses of this mineral and has generally been accounted for by assuming the presence of varying amounts of the leucopyrite molecule,  $\text{Fe}_3\text{As}_4$ . In this case calculation shows the presence of 14% of leucopyrite.

The authors are very glad to acknowledge the considerable help given by Professor Charles Palache in the preparation of this paper.

## THE PREPARATION OF OPTICALLY CLEAR SELENIUM FOR USE IN INDEX MEDIA<sup>1</sup>

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### ABSTRACT

In the preparation of selenium-sulphur mixtures for use as index media, one is encountered with the difficulty of obtaining selenium which is optically clear when melted into thin films. Minute particles of another phase are commonly present which interfere with the index determinations. These have been identified as selenium dioxide, and a method is described for the removal of this material by distillation in an atmosphere of carbon dioxide.

### INTRODUCTION

In the determination of the optical properties of minerals, by the immersion method, materials frequently are encountered the refractive indices of which lie above those of the usual immersion media. For index determinations between values of 2.05 and 2.75 sulphur-selenium mixtures have been recommended.<sup>2</sup>

<sup>1</sup> Published by permission of the Director of the National Bureau of Standards of the U. S. Department of Commerce. Paper No. 7 of the Portland Cement Association Fellowship at the Bureau of Standards.

<sup>2</sup> Larsen and Merwin; *Am. J. Sci.*, 34, 42, (1912).