

cides with the diagonal of this face; for if a twinned plate be examined with the ordinary microscope between two Nicols, the line of separation of the two crystals is observed to be situated very approximately at 45° to the trace of the plane of the optic axes of each of the two crystals, the plane of the optic axes of one crystal being at 90° to that of the other.

This coincidence, which is necessary in the prismatic system, but not in the oblique, gives a fresh argument in favour of the system being prismatic.

We may therefore conclude that the greater part of the crystals of leucophane are twinned and most probably hemihedral. It will be interesting to obtain evidence whether other crystals besides those mentioned above present the same hemihedrism.

VIII. *Crystallographic Notes.* By W. J. LEWIS, M.A.,
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[Plate III.]

Barium Nitrate.

LAST autumn my friend Mr. T. Davies, of the British Museum, kindly brought me a fairly large crystal with a very large number of faces on it. It had been found at the bottom of a reagent-bottle which had been put aside for many years. The solution, owing to a faulty stopper, had all evaporated, leaving this single crystal. The label had been lost; so, after a crystallographic investigation, I scraped off a very small portion from a part on which were no crystal-faces. By means of this I was able to determine that the crystal was one of barium nitrate. I have thought that a description of its crystallography would be interesting, both on account of the remarkable development of its faces and its decided tetartohedrism. The facts already known about barium nitrate are that it crystallizes in the cubic system, shows a hemihedrism with parallel faces, and has the forms $\{1\ 0\ 0\}$, $\{1\ 1\ 1\}$, $\pi\{2\ 1\ 0\}$, and $\kappa\pi\{1\ 2\ 4\}$ (Scacchi, *Pogg.* cix.).

The forms observed on the crystal in question are $a = \{1\ 0\ 0\}$,

* Read April 12, 1877.

$t = \kappa\pi\{1\ 2\ 4\}$, $h = \kappa\pi\{\bar{1}\ 2\ 4\}$, $n = \kappa\pi\{5\ 3\ 1\}$, $l = \kappa\{3\ 1\ 1\}$,
 $s = \kappa\{2\ 1\ 1\}$, $o = \kappa\{\bar{1}\ 1\ 1\}$. A glance at the stereographic projection (fig. 1, Plate III.) of these forms shows that t , n , and l occupy alternate octants, and that o , s , and h occupy the remaining octants. The forms t and h are complementary, and make up the hemihedral form with parallel faces $\pi\{1\ 2\ 4\}$. The physical character of the faces of this form in adjacent octants manifests, however, the tetartohedrism of the crystal; for the faces h are large and smooth, the faces t small and rough. The faces n are tetartohedral and well developed in alternate octants; they are for the most part bright; but the most careful examination in the remaining octants failed to discover the slightest trace of corresponding planes. Similarly the faces o , which are large and bright, were found only in alternate octants. The faces l are fairly developed and bright. The faces s are very small but fairly bright. The faces of the cube a are large and bright.

The principal zones on the crystal are those containing the planes anl , $a_s s_o$, at, ths, h_p , ol, n, h . These afforded considerable aid in seeking for traces of planes, and also in some instances in determining the real positions of some of the badly developed faces. The following are the most important angles of the combination, with which the measurements accorded well:—

	Calc.	Found.		Calc.	Found.		Calc.	Found.
at	$29^\circ 12'$	$29^\circ 17'$	an	$32^\circ 19'$	$32^\circ 9'$	$\left[\begin{array}{l} ol, \\ on, \\ oh, \end{array} \right.$	$58^\circ 31'$	0°
at	$77^\circ 24'$	$77^\circ 14'$	an	$80^\circ 16'$	$80^\circ 22'$		$72^\circ 58\frac{1}{2}'$	$73^\circ 8'$
at	$64^\circ 7\frac{1}{2}'$	$64^\circ 1'$	an	$59^\circ 32'$			$112^\circ 12\frac{1}{3}'$	

The stereographic projection (fig. 1) shows very clearly the zones and the arrangement of the poles. Fig. 2 is an orthogonal projection on one of the faces of the cube; and fig. 3 is one in which the axes have been projected in the usual manner. To avoid confusion, the small planes s have been omitted in the latter figure. The crystal is elongated in a direction nearly coinciding with the normal to a face of the tetrahedron. An oval ring seems to have been first deposited; and on this the crystal has grown, vaulting itself on the lower surface so as not to cling to the bottle. There were no definite crystal-faces to be seen on this concave portion. The top is also irregular and indefinite. The crystal introduced into the polari-

zing microscope between crossed Nicols depolarized the light. When the illumination was monochromatic no perceptible change could be observed in the light when the plate carrying the crystal was rotated, nor could the light be extinguished by rotating the analyzer. More exact experiments on the depolarization could not be made without destroying the crystal.

On some crystals of barium nitrate crystallized out of solution during the course of a few weeks, the forms $\kappa\{111\}$, $\kappa\{\bar{1}11\}$, $\{101\}$, and $\kappa\{\bar{1}22\}$ were found. The planes $\kappa\{\bar{1}11\}$ seemed to be smoother and brighter than those of $\kappa\{111\}$; and the edges of the former carried the planes $\kappa\{\bar{1}22\}$.

Sphene.

On a crystal from the Tyrol, obtained by me some years ago, two rough ill-developed planes are situated on the quoin formed by the two planes $n = \{123\}$ and the base $c = \{001\}$. They look almost like the result which would be produced by slightly grinding down this quoin. The exact symmetry of the two planes, as also the frequency of their occurrence, show them, however, to be really planes. Hesseberg, who devoted considerable attention to this mineral, has noticed similar faces on the crystals from the Zillertal, described in his *Min. Notizen*, vi., and has introduced them in two of the figures of these crystals. As this part of the *Notizen* is out of print, I have copied one of these figures (fig. 34), in which the small triangular dotted planes are those under consideration. Hesseberg says that he found them more or less clearly developed on almost all the crystals from this locality. He expresses, however, his conviction that the rough portion is only a continuation of the plane n .

Lately I obtained several crystals on which these planes were very fairly developed, of one of which fig. 4 is a projection. They give such excessively bad reflections, that it was only by observing with a ray of sunlight thrown into the room by a mirror, and by slightly oiling the surfaces, that reliable measurements were obtained. The form calculated from these measurements is $\{3, 3, 10\}$, adopting the axial system given in Miller's 'Mineralogy.' The following are the angles observed and calculated:—

	Observed.	Calculated.
$n\phi$	$11^{\circ} 2'$	$10^{\circ} 59'$
n,ϕ	$33 33\frac{1}{4}$	$33 19$
$\phi\phi,$	$22 33\frac{1}{2}$	$22 31$
$c\phi$	$27 42\frac{1}{2}$	$27 47\frac{1}{3}$

Gold.

Measurement of a large though imperfect crystal in the British Museum showed it to be a combination of the cube with the tetrakisshexahedron $\{410\}$ and the triakisoctahedron $\{811\}$. As the faces were very dull, and but rough measurements could be obtained, I was glad to confirm this observation by the examination of a crystal showing the same combination in Mr. Ludlam's beautiful collection, which he was good enough to lend me. The angles measured on the latter crystal agree fairly well with the calculated angles.

	Measured.	Calculated.
$(410, 811)$	$9^{\circ} 25'$	$9^{\circ} 52'$
$(410, 401)$	$20 18$	$19 44$

I saw recently a very beautiful crystal of the same combination in the collection of the École des Mines, Paris. In the two former the planes $\{811\}$ are deeply striated parallel to their intersection with the faces of the cube.

IX. *On the Conditions of Perpendicularity in a Parallelepipedal System.* By H. J. S. SMITH, F.R.S., Savilian Professor of Geometry in the University of Oxford*.

1. THE conception of a parallelepipedal system (*i. e.* of a space divided by three systems of equidistant parallel planes into similar and equal parallelepipeds) may be regarded as forming the basis of the usually received theory of crystallography. It is the object of the present note to state some of the conditions for the perpendicularity of lines and planes in such a system. The results of this inquiry (which has been undertaken at the request of Professor N. S. Maskelyne, and owes much to his suggestions) are submitted to the Crystallogical Society with great diffidence, because they do not

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