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Art. XXX.—*Hinsdalite, a new mineral;* by E. S. Larsen, Jr., and W. T. Schaller.

Introduction.

The new mineral here described was collected by one of the authors (E. S. L.) in the summer of 1910 while engaged in the areal mapping of the geology of the San Cristobal quadrangle, Colorado. It was found in considerable quantity at an elevation of about 9,950 feet, on one of the dumps of the Golden Fleece Mine, which is about three miles south of Lake City, Hinsdale County, Colorado. The name *hinsdalite*, proposed for the new mineral, is derived from the name of the county in which it is found. The chemical analysis showed hinsdalite to be a hydrous sulphate and phosphate of lead and aluminum with a little strontium replacing the lead. It is therefore the lead analogue of svanbergite or the aluminium analogue of corkite.

Occurrence.

(E. S. Larsen.)

The country rock of the mineral occurrence belongs to the Picayune member of the Silverton Volcanic Series and consists of tuffs, lava flows, and intrusive bodies of rhyolite, latite, and andesite. The tunnel of the mine was not accessible, but judging from the material on the dump, the new mineral occurs as an original component of a vein whose chief constituents, in the order of their abundance, are quartz, hinsdalite, barite, pyrite, galena, tetrahedrite, and rhodochrosite. The vein material contains bands of almost pure, coarsely granular hinsdalite, an inch or more across. These bands are bordered by a finely crystalline aggregate of quartz and hinsdalite, in which are imbedded well-formed crystals, often a centimeter across, of the new mineral. Beyond the fine aggregate is nearly pure, granular quartz or quartz and barite. The galena and tetrahedrite and, to some extent, the pyrite, are concentrated in the quartz-hinsdalite aggregate.

Description of Mineral.

(E. S. Larsen.)

The granular hinsdalite is rather coarsely crystalline and the mineral shows a strong tendency to develop crystal faces. Some of the larger imbedded crystals are rhombohedrons resembling cubes, with a perfect cleavage (basal) truncating

one corner. The crystal faces are always dull and rough, so that accurate measurements were impossible. Several crystals, however, could be measured with a contact goniometer and gave for the angle $r \wedge r'$ the values: 91·0°, 91·3°, 91·2°, 91·7°, average 91·3° or 91° 18′. The value of the c axis, computed from this average angle, is 1·2677. Measurements of the angle between the cleavage and the adjacent rhombohedron varied

FIG. 1.

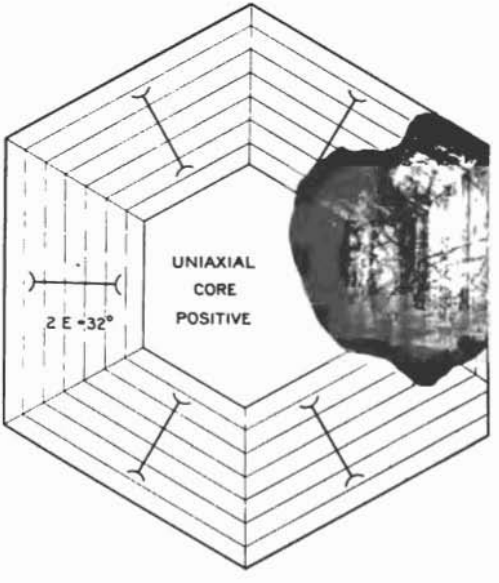

FIG. 1. Basal section of hinsdalite.

from 56° to 59°, with an average of 57° 18′. The calculated value for the angle $c \wedge r$ is 55° 40′.

The faces commonly developed on the larger crystals are the unit rhombohedron r $\{10\bar{1}1\}$ and the base c $\{0001\}$. The smaller crystals are tabular, parallel to the base, and have both the positive and negative rhombohedrons. The basal sections are hexagonal, while the prismatic sections are lath-shaped, with pointed ends. The optical properties show, however, that the mineral is only pseudo-rhombohedral.

The perfect basal cleavage gives wavy and striated surfaces, and the striations are in some cases developed in three directions, forming hexagonal markings. The hardness of hinsdalite is about 4 1/2 and the density is 3·65. The streak is colorless. The luster is vitreous to greasy. The crystals are nearly

colorless, with a greenish cast, but much of the mineral is dark gray from minute inclusions.

A microscopic study of thin sections revealed the fact that the larger crystals, at least, are strongly zoned. This zonal structure is easily seen in ordinary light, or even in the hand specimens. Some of the zones are much more subject to alteration than others. Between crossed nicols the different zones show slightly different interference colors.

On account of the zonal growth it is not possible to obtain accurate and consistent optical data. Cleavage pieces of the mineral are not isotropic, but are nearly normal to a positive, acute bisectrix. The values of 2E vary from nearly 0° to 40°. Dispersion of the optic axes was not perceptible. In many cases the core of the larger crystals is nearly uniaxial, and the most common value of 2E for the outer zone is 32°. The variation in the value of 2E is probably largely due to the zonal growths, though in some cases it is clearly due to overlapping of twin lamellæ. Basal sections of some of the crystals are divided into six radial segments and the plane of the optic axes for each segment is normal to the hexagonal prism edge and to the striations.

These relations are shown in fig. 1, where the diagrammatic part shows the optical relations and the photograph shows a basal section (under crossed nicols) of an incomplete hinsdalite crystal.

Accurate measurement of the angle between the segments was not feasible, though it approximates closely to 60°. Similar optical anomalies have been described for hamlinite* and for jarosite†, both members of the same series of minerals to which hinsdalite belongs (see paper in the number following).

The indices of refraction for hinsdalite were determined by the oil immersion method. The values of α and β are nearly the same and vary from 1·66 to 1·68, with an average value of 1·67; the value of γ varies from 1·678 to 1·700. The birefringence was measured by comparing the interference color of sections parallel to the plane of the optic axes with that of the same section of quartz. For the greater part of the hinsdalite crystal the value of 0·019 was obtained. Some of the narrow zones gave a value as low as 0·016. Therefore the indices of refraction for hinsdalite may be taken as: $\alpha = 1{\cdot}670$, $\beta = 1{\cdot}671$, $\gamma = 1{\cdot}689$.

* Bowman, H. L.: On Hamlinite from the Binnenthal, Switzerland. Mineral. Mag., vol. xiv, p. 389, 1907.

† Slavik, Franz: Mineralogische Notizen. Zeitschr. Kryst., vol. xxxix, p. 297, 1904.

Chemical Composition.

(W. T. Schaller.)

The new mineral is infusible, becomes blue when heated with cobalt nitrate, and gives a lead reaction when fused with sodium carbonate on charcoal. A little water is given off when it is heated in a closed tube. It is practically insoluble in acids.

After the qualitative analysis had shown what the essential components of the mineral were, a preliminary quantitative analysis was made, the approximately correct results not being here given. With a knowledge of the composition and the experience gained in making the preliminary analyses, the chemical composition of hinsdalite was determined on carefully selected and pure material. The results obtained, together with the ratios deduced therefrom, are shown below.

Analysis and ratios of hinsdalite.

PbO	31·75	·142	·172	1·93 or 2
SrO	3·11	·030		
CaO	trace	----		----
Al_2O_3	26·47	·260		2·92 or 3
SO_3	14·13	·177		1·99 or 2
P_2O_5	14·50	·102		1·14 or 1
H_2O	10·25	·570		6·40 or 6 (= 6 × 1·07)
	100·21			

The ratios agree well with the formula, $2PbO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$, except that the P_2O_5 and H_2O are a little high. A comparison of the analysis with the calculated percentages is shown below. The sample analyzed consists of 82·56 per cent of $2PbO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$, and 17·44 per cent of $2SrO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$ (svanbergite).

Under 1 is given, in the table below, the analysis of the Colorado mineral; under 2, the calculated composition of $2PbO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$; under 3, the composition calculated for a mixture of 82·56 per cent of the pure lead mineral and 17·44 per cent of the pure strontium mineral (svanbergite); and under 4, for comparison, the calculated composition of pure svanbergite.

Comparison of analysis with calculated composition.

	1	2	3	4
PbO	31·75	38·37	31·68	----
SrO	3·11	----	3·91	22·43
Al_2O_3	26·47	26·36	27·55	33·19
SO_3	14·13	13·77	14·39	17·32
P_2O_5	14·50	12·21	12·76	15·37
H_2O	10·25	9·29	9·71	11·69
	100·21	100·00	100·00	100·00

The Colorado mineral, or at least that sample of it which was analyzed, represents a strontium hinsdalite just as the only good analysis of svanbergite really represents a lead svanbergite.

The water of the mineral is all water of constitution, that is, it is driven off only at a high temperature. It was found that practically no water was expelled up to 390°, the following table showing the results obtained :

Loss of water.

Temp.	Total loss in weight
110°	0·02 per cent
170°	0·02 "
250°	0·08 "
390°	0·08 "
590°	9·24 "

The crucible was heated in an air oven for the temperatures up to 250° ; above this heat, an electric furnace was used. The results show that the water is lost between 400° and 600°, approximately.

In its relation to other members of the group, hinsdalite is best considered as the lead type of svanbergite. It may just as well be considered as an aluminous corkite, the formula for corkite* being $2PbO.3Fe_2O_3.2SO_3.P_2O_5.6H_2O$. The systematic place of hinsdalite is thus well fixed, and it adds another well-defined mineral to a group which already includes a considerable number of minerals (see paper in the number following). The relations of these minerals, closest related to hinsdalite, can be seen in the following tabulation:

Svanbergite...	2SrO.	$3Al_2O_3$.	$2SO_3$.	P_2O_5.	$6H_2O$.	Rhomb., $c=1·2063$
Hinsdalite....	2PbO.	$3Al_2O_3$.	$2SO_3$.	P_2O_5.	$6H_2O$.	Rhomb., $c=1·2677$
Corkite	2PbO.	$3Fe_2O_3$.	$2SO_3$.	P_2O_5.	$6H_2O$.	Rhomb., $c=1·1842$
Beudantite ...	2PbO.	$3Fe_2O_3$.	$2SO_3$.	As_2O_5.	$6H_2O$.	Rhomb., $c=1·1842$

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* Compare Lacroix, Minéralogie de la France, vol. iv, p. 592, 1911.