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# CANBYITE, A NEW MINERAL

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## OCCURRENCE.

Some thirty-five or forty years ago, when the Brandywine Quarry at Wilmington, Delaware, was in operation, Mr. Fred Hilbiber, then living in that city, discovered in this quarry the minerals here described. The quarry is located a quarter mile northwest of the Baltimore and Ohio Railroad bridge on Brandywine Creek. It is at present used as a storage yard adjacent to a leather manufacturing plant.

The country rock is a gabbro, containing numerous quartz stringers and masses due to the effects of intrusive granite, and showing the minerals enumerated below. The minerals associated with the canbyite are as follows:

Bornite: pure masses, iridescent, weighing altogether several pounds.
Chalcopyrite: alone, and associated with bornite and pyrite.
Chalcocite: associated with garnet and hisingerite.
Pyrrhotite: narrow stringers associated with other sulphides.
Pyrite: brilliant simple cubes, 1 to 3 mm. in diameter.
Marcasite: coating surfaces of the rock, decomposing rapidly on exposure.
Garnet: fibrous crystalline crusts associated with hisingerite.
Apatite: bright crystals of a dark olive green color, showing prism, unit pyramid, and base; somewhat twisted and distorted by rock movements; embedded in quartz. Largest crystal observed, 2×5 cm.
Quartz: small crystals on gabbro, associated with calcite and stilbite.
Calcite: white crystals, about 3×5 mm. in size, terminated by $r(10\bar{1}1)$, showing also prominently $M(40\bar{4}1)$ with a steep scalenohedron near $(31\bar{4}2)$. Also small unit rhombohedrons.
Chabazite: well formed crystals, the largest observed being 0.8 cm. in diameter. Colors, dark olive green, salmon, dark brown to light brown.
Natrolite: white and delicately acicular. Complete radiations, 2.2 cm. in diameter, crusts and veins. Associated with calcite, bornite and chalcopyrite, as are the other zeolites, which rest upon the sulphides.
Stilbite: radiations 1.3 cm. in diameter, single crystals and sheaves 0.5 cm. in size; drusy surfaces; colors, gray-green, salmon, orange-yellow to white.

Laumontite: opaque, cream-colored crystals 0.5 cm. long, on gabbro. Sharp free crystals showing prism and base, which are today in a good state of preservation.
Epidesmine: sheaf-like rosettes 1 mm. in diameter, composed of colorless, transparent crystals, associated with calcite and natrolite.
Hisingerite: associated with canbyite, garnet, and sulphides.

The optical properties of the epidesmine correspond closely with those given for this mineral in E. S. Larsen's Tables; many of the associated minerals, however, are filled with microscopic inclusions of rectangular or rod-like shapes and brown color, which are inferred to be hisingerite, and which may be responsible for the abnormal refractive indices, particularly the low alpha index values, shown by the minerals at this locality.

## ANALYSIS AND OPTICAL PROPERTIES.

The analysis indicates that the mineral is essentially a hydrated ferric silicate. While its composition can be practically duplicated by several published analyses of hisingerite, the present material is completely crystalline with definite optical properties, while hisingerite is a typically amorphous mineral and is always isotropic optically, or, at most, contains only rare, isolated and very minute birefracting grains. For this reason, and in consideration of several exhaustive treatments of the several groups of ferric silicate minerals which are awaiting publication, it seems most logical and less confusing to designate the present mineral by a distinct name. The name proposed is *canbyite*, in honor of the founder of the Natural History Society of Delaware, thru the courtesy of which society this mineral was made available for study.

Canbyite is thus a crystalline compound corresponding to the amorphous hisingerite, altho it seems improbable that it is the only crystalline ferric silicate corresponding in composition to the hisingerite group.

The canbyite occurs as a constituent of crusts which rest on a peculiar coarsely crystalline, translucent quartz having a bluish green color and greasy luster. The quartz contains scattered rhombic crystals of grayish feldspar, up to 2 cm. in diameter, crystals of pyroxene, and masses of chalcopyrite. The canbyite forms a platy dark brown layer from 1 to 2 mm. in thickness next to the quartz. This is immediately overlain by a fine columnar

layer of garnet, the minute columns of which stand perpendicular and terminate above in a minute druse of ill-defined crystals. The garnet is transparent and pale greenish brown under the microscope. It is completely isotropic with an index of refraction above 1.82. Above the garnet there is a layer from 1 to 10 mm., in thickness of sulphides, mainly chalcopyrite and chalcocite upon which rest bright cubes of pyrite. The pyrite crystals are overlain by a thick layer of amorphous hisingerite which was originally botryoidal but has been filled completely with minute contraction cracks. The hisingerite is clear golden brown under the microscope and is isotropic. Its index of refraction is variable, but the majority of the grains range between 1.45 and 1.47. A partial analysis of the hisingerite, made on only 0.0517 gram of material gave the following results:

ANALYSIS OF HISINGERITE

| | PER CENT | RATIOS | |
|---|---|---|---|
| $SiO_2$ | 34.04 | .56 | .28×2 |
| $Fe_2O_3$ | 45.84 | .29 | .29×1 |
| $H_2O$ plus | 9.09 | .51 | .26×2 |
| $H_2O$ minus | 9.67 | .54 | .27×2 |

The specimens from which the analyzed sample of canbyite was taken consisted of flat pieces of translucent greenish quartz coated on both sides with a platy layer 2 mm. or less thick, of the canbyite. The optical properties of this sample were worked out sufficiently to give a satisfactory knowledge of the character of the material analyzed. The sample was homogeneous, pure, and entirely crystalline. It has been impossible to obtain any subsequent samples which were not more or less contaminated with amorphous hisingerite. Under the microscope the material analyzed was coarsely crystalline, transparent, golden to amber brown and non-pleochroic. Certain flakes lie on the cleavage and show no traces of other cleavages and apparently show the emergence of the obtuse bisectrix perpendicular to the cleavage plate. Other grains whose orientation with reference to the cleavage was not determined give an acute biaxial figure with 2V very small, optically negative, dispersion perceptible, $\rho > \nu$(?). A majority of the grains show the trace of a cleavage in their longest direction and the extinction is

parallel to this cleavage. Some grains show lines of dotted inclusions, in one grain intersecting the cleavage at an angle of 18°. The indices of refraction are decidedly variable, the average values for the analyzed sample being about $\alpha=1.562$, $\beta=1.580$, $\gamma=1.582$. Subsequent samples showed a variation of the alpha index from 1.552 up to 1.595, although the other properties remain unchanged. This variation of the refractive index is apparently not due to varying water content as the index of a given sample remained unchanged when the sample was exposed alternately to very moist and extremely dry atmosphere. Most of the canbyite is more or less contaminated with grains of isotropic hisingerite although no hisingerite was present in the analyzed sample. As contrasted with the hisingerite analyzed above, this has in each case about the same index of refraction as the associated canbyite.

Only 0.2 gm. of material of satisfactory purity was available for quantitative analysis giving only a single portion. Water was determined by drying at 110°C. and loss on ignition. The analysis was carried out by the usual methods after fusing the carefully ignited mineral with sodium carbonate. The amount of material did not permit quantitative determination of the state of oxidation of the iron and manganese but qualitative tests for ferrous iron and manganic manganese gave negative results. The analysis (by Earl V. Shannon) gave the following results and ratios:—

ANALYSIS OF CANBYITE

| | PER CENT | RATIOS | | | |
|---|---|---|---|---|---|
| $SiO_2$ | 32.85 | .545 | .548 | .091×1 | 1.01×6 |
| $TiO_2$ | .26 | .003 | | | |
| $Fe_2O_3$ | 40.70 | .255 | .281 | .094×3 | 1.05×3 |
| $Al_2O_3$ | 2.64 | .026 | | | |
| MnO | .74 | .010 | .088 | .088×1 | .98×1 |
| CaO | 1.50 | .027 | | | |
| MgO | 2.05 | .051 | | | |
| $H_2O$ above 110°C | 7.90 | .439 | | .088×5 | .98×5 |
| $H_2O$ below 110°C. | 11.40 | .633 | | .090×7 | 1.00×7 |
| Total | 100.04 | | | | |

The formula may most simply be written by regarding the water given off above 110°C. as basic, and considering the miscellaneous small amounts of bivalent bases as occurring in replacement of this,

the formula then being, $2H_2O.Fe_2O_3.2SiO_2.2H_2O$, or $H_4Fe^{III}{}_2Si_2O_9.2H_2O$. This formula requires the following composition:

| | |
|---|---|
| $SiO_2$ | 34.23 |
| $Fe_2O_3$ | 45.32 |
| $H_2O+$ | 10.23 |
| $H_2O-$ | 10.22 |
| | 100.00 |

## THE CRYSTALLOGRAPHIC WORK OF GUSTAVUS HINRICHS

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The recent demise of Dr. Gustavus Detlef Hinrichs, at the ripe age of four score and ten years, removes from our midst a rather unique personage in American mineralogy. His chief investigations date half a century ago, so that those of the present generation know personally little of his accomplishments.

Hinrichs was a mathematical crystallographer, ranking with the distinguished Haidinger of Vienna, and the great Klein of Berlin, and the only one this country ever produced. A pioneer of pioneers in what we now know as physical chemistry, his researches in this field were so many, so fundamental and so brilliant that one loses sight of the fact that he also did so much creditable work in mineralogy, meteorology and geology that in each of these fields his name will be long remembered.

Hinrichs' work on the structure of crystals had an unusual and especially broad prospect and an illuminating bearing on our modern concept of the atom. He early sought to show that the chemical nature of a substance found visible expression in its crystal form. His especial mission was the mathematical and crystallographic demonstration of the unity of matter, the foundation of which he designated as *Pantogen*.

Hinrichs was not so widely known among American scientists as he should have been. Most of his numerous publications were issued in Europe in languages other than English. This was due no doubt in large measure to early rebuff which he received in this country; and with a sensitive and high strung soul such as his the affair rankled in his breast to his dying day. In order to get his