

Canaphite

*a new sodium calcium phosphate hydrate
from the Paterson area, New Jersey*

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ABSTRACT

Canaphite, $\text{CaNa}_2\text{H}_2(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$, is monoclinic, space group Pa , with unit cell parameters $a = 10.529(5)$, $b = 8.48(1)$, $c = 5.673(4)\text{\AA}$, $\beta = 106.13(6)^\circ$, $V = 486.4(9)\text{\AA}^3$, $Z = 2$. Microprobe analysis yielded $\text{Na}_2\text{O} = 16.5$, $\text{MgO} = 0.2$, $\text{CaO} = 17.5$, $\text{P}_2\text{O}_5 = 43.4$, H_2O (by DTA-TGA) = 21.8, sum = 99.4 weight %, which corresponds to $\text{CaNa}_2\text{H}_2(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$. Canaphite occurs as colorless, prismatic, lustrous, monoclinic crystals, elongate on [001], tabular on {010} and composed of the forms {010}, {001} and {100}. Physical properties include: density 2.24 g/cm^3 (2.27 calc.); hardness (Mohs) approximately 2; white streak; and perfect {010} cleavage. The strongest lines in the X-ray powder pattern are (d , I/I_0 , hkl): 8.47 80 010; 5.44 80 001; 4.36 70 210, 20 $\bar{1}$; 3.06 100 31 $\bar{1}$, 211; 2.608 90 32 $\bar{1}$. Canaphite occurs as clusters of colorless crystals coating stilbite, purportedly from Haledon, New Jersey. The name is for the chemical composition.

INTRODUCTION

The new species described herein was first noted by the late L. Neal Yedlin and preserved in his micromount collection as an unknown. His micromount collection was bequeathed to the Smithsonian Institution and, during the curation of this collection, the crystals we describe were called to our attention by Herbert Corbett. Because the prismatic, well-formed crystals have a unique appearance, and because they had not previously been observed by us in examination of zeolite assemblages, we initially suspected that this might be a new species. We therefore obtained X-ray powder diffraction data and a qualitative microprobe analysis; these preliminary investigations confirmed that it is a new species and our subsequent study has validated this observation and led to its characterization.

The new phase is named *canaphite* in allusion to the chemical composition, calcium sodium hydrogen phosphate. The new mineral and the name were approved prior to publication by the Commission on New Minerals and Mineral Names, I.M.A. Type material is preserved in the Smithsonian Institution under catalog #160286.

CRYSTALLOGRAPHY

Morphology

Canaphite occurs only as lustrous, euhedral, prismatic crystals elongate on [001] and tabular on {010}. The forms present are {010}, {100} and {001} with {010} dominant. Individual crystals

are up to 0.5 mm long. A representative cluster of canaphite crystals is shown in Figure 1.

X-ray crystallography

Crystals were studied using Weissenberg and precession techniques which showed that canaphite is monoclinic with extinctions consistent with space groups Pa or $P2/a$. Three-dimensional intensity data were measured in preparation for a crystal-structure analysis. These were analyzed for centrosymmetry using the $N(Z)$ test, showing that canaphite is acentric and therefore has space group Pa (R. L. Freed, personal communication). Powder X-ray diffraction data are given in Table 1. They were obtained using a 114.6-mm diameter Gandolfi camera, $\text{CuK}\alpha$ radiation, Si as an internal standard, and a polycrystalline specimen. The lattice parameters were refined using these data, and are: $a = 10.529(5)\text{\AA}$, $b = 8.48(1)\text{\AA}$, $c = 5.673(4)\text{\AA}$, $\beta = 106.13(6)^\circ$.

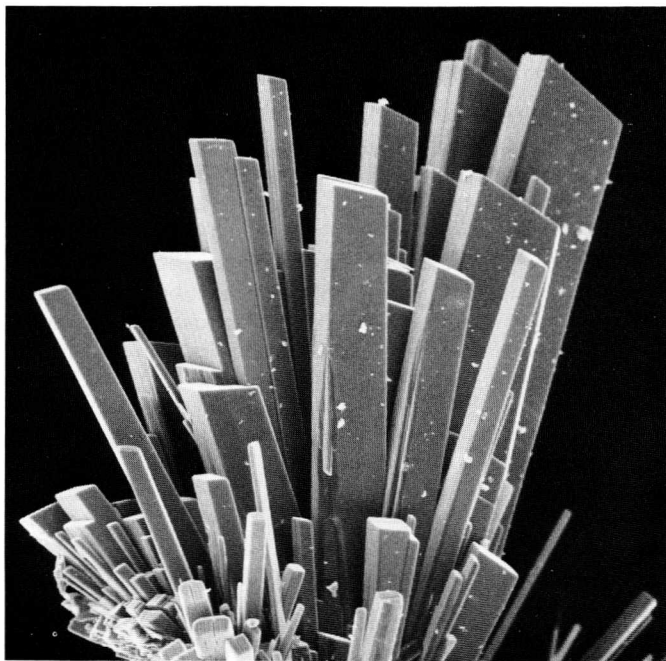


Figure 1. Radiating cluster of canaphite crystals exhibiting typical morphology for this species. The largest crystal is approximately $100\ \mu\text{m}$ in width.

CHEMISTRY

Canaphite was chemically analyzed using an ARL-SEMQ electron microprobe utilizing an operating voltage of 15 kV and a sample current of 0.025 μA , measured on brass. The standards used were montgomeryite (Ca, Mg, P) and maricite (Na). A wavelength-dispersive microprobe scan indicated the absence of any elements with atomic number greater than 9, except those reported herein. Water was determined by DTA-TGA, which indicated a total H_2O content of 21.8 weight %. The resultant combined analysis yields $\text{Na}_2\text{O} = 16.5$, $\text{MgO} = 0.2$, $\text{CaO} = 17.5$, $\text{P}_2\text{O}_5 = 43.4$, $\text{H}_2\text{O} = 21.8$, total = 99.4 weight %. Unit cell contents, calculated using the unit cell parameters and the observed density, yield $\text{Ca}_{2.05}\text{Na}_{3.49}\text{Mg}_{0.03}\text{H}_{4.39}(\text{PO}_4)_{4.01} \cdot 5.73\text{H}_2\text{O}$, or ideally, $\text{CaNa}_2\text{H}_2(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$ with $Z = 2$.

Special care was taken to measure water using a Mettler TAI thermoanalyzer equipped with an Inficon IQ 200 quadrupole mass spectrometer for the determination of gases evolved during heating. The sample lost 4.2 weight % during the 3 hour period prior to analysis in which the instrument was pumped down and the vacuum established. During this period the temperature was 21° C and the pressure was reduced from approximately 1×10^{-3} to 1×10^{-7} torr. At the end of the 3 hours the sample was still losing weight at a rate of 0.7 weight % per hour when the analytical run was initiated. A water loss of 17.6 weight % was identified by mass spectrometer, occurring between 80° and 430° C. This was composed of a major loss with a maximum rate of loss at 200° C and a smaller loss with a maximum rate of loss at 310° C. The total water loss was 21.8 ± 1.0 weight %, and no direct loss of H_2 was observed. Between 800° and 1445° C the sample lost a further 47.2 weight % and melted, but O_2 and minor CO_2 were the only evolved gases that could be identified with the mass spectrometer.

The loss of 4.2 weight % water under vacuum represents 0.75 H_2O per formula and suggests that some of the water is fairly loosely bound in the canaphite structure. The two-stage water loss between 80° and 430° C is difficult to interpret because there is a considerable overlap between the two events; however the approximate ratio of the two peaks is 5.5:1. This represents approximate losses of 2.75 H_2O followed by 0.5 H_2O per formula. The large loss near the end of the thermogram was associated with melting of the sample and was produced by oxygen and the boiling off of unknown elements that were deposited on the walls of the vacuum column as the temperature decreased along the path to the spectrometer.

PHYSICAL AND OPTICAL PROPERTIES

Canaphite is colorless and transparent. The hardness could not be measured precisely, but is approximately 2 (Mohs). The density, determined using heavy liquid techniques, is 2.24 g/cm^3 (2.27 g/cm^3 calc.); luster is vitreous on cleavage and fracture surfaces. There is an {010} cleavage which is perfect and easily produced; two other poor cleavages having the apparent indices {100} and {001} were observed in crushed fragments using the optical microscope. There is no fluorescence in either longwave or short-wave ultraviolet radiation.

Optically, canaphite is biaxial (-), with indices of refraction $\alpha = 1.496(2)$, $\beta = 1.504(2)$, $\gamma = 1.506(4)$; $2V = 52(5)^\circ$, (52.9° calc.), in sodium light. There is no pleochroism. Orientation is $Z = b$, $XAc = 25^\circ$. No dispersion is discernible.

OCCURRENCE

We have no direct evidence of the precise geologic occurrence of canaphite. The mineral was found on specimens of stilbite in the mineral collection of the late L. Neal Yedlin, which were labeled "Haledon, N.J. 8-19-66" in his handwriting. There is no attached rock matrix. The stilbite rests on quartz.

This quartz has numerous rectangular cavities, quite similar to those found in other samples from the Watchung Mountains. Similar molds have been attributed to pre-existing anhydrite and

Table 1. Powder diffraction data for canaphite.

I/I ₀	d(Obs)	d(Calc)	hkl	I/I ₀	d(Obs)
80	8.47	8.48	010	10	1.927
20	6.49	6.50	110	5	1.897
80	5.44	5.45	001	5	1.877
60	5.06	5.06	200	1	1.840
40	4.60	4.60	11 $\bar{1}$	10	1.784
		4.58	011		
70	4.36	4.36	20 $\bar{1}$	10	1.725
		4.34	210	5	1.715
40	3.94	3.91	120	40	1.688
60	3.87	3.88	21 $\bar{1}$	10	1.659
		3.85	111	10	1.640
40	3.38	3.35	121		
		3.35	021		
60	3.28	3.28	201		
				5	1.600
100	3.06	3.06	211	5	1.573
		3.08	31 $\bar{1}$	10	1.535
60	2.748	2.737	20 $\bar{2}$	5	1.525
2	2.691	2.690	11 $\bar{2}$	2	1.496
90	2.608	2.608	32 $\bar{1}$		
20	2.529	2.529	400	2	1.474
30	2.482	2.472	41 $\bar{1}$	5	1.454
5	2.462	2.467	230	2	1.439
40	2.387	2.383	31 $\bar{2}$	10	1.421
30	2.307	2.299	22 $\bar{2}$	5	1.403
20	2.207	2.206	42 $\bar{1}$	10	1.382
20	2.161	2.161	202	2	1.320
30	2.097	2.094	21 $\bar{2}$	10	1.269
20	1.998	1.002	13 $\bar{2}$		
5	1.975	1.976	14 $\bar{1}$		
		1.975	041		

glauberite by Schaller (1932) and further discussion was provided by Peters and Peters (1978). These molds lend further credence to the attribution of at least the general locality to the Paterson area. Hence, the only available evidence for the type locality is that gleaned from Mr. Yedlin's notations. Inasmuch as he was a careful collector, noted for taking pains with attribution of provenance, there is a high probability that the locality given is correct.

Haledon, New Jersey, is in the Watchung Mountains of northern New Jersey. The most likely site within Haledon is Braen's quarry where minerals have been collected in recent years. The quarries in the local Triassic traprocks are noted localities for zeolites and the occurrence of stilbite in the area is expected. For a review of the minerals found in the local quarries, the reader is referred to Peters and Peters (1978).

ACKNOWLEDGMENTS

The authors are indebted to Robert Ramik of the Royal Ontario Museum for obtaining the DTA-TGA analysis, and to Thomas A. Peters for helpful discussions concerning the locality. We take special note of the contribution of the late L. Neal Yedlin (1908-1977) in recognizing the uniqueness of this mineral and in preserving it for subsequent investigations, and of Herbert Corbett for calling it to our attention.

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