Barnesite $(Na,Ca)_2V_6^{5+}O_{16}\cdot 3H_2O$

Crystal Data: Monoclinic. *Point Group:* $2/m$. As small clusters of subparallel to radiating bladed to fibrous crystals, elongated along [010], to 0.5 mm; in spherical aggregates, and as botryoidal to velvety coatings.

Physical Properties: *Cleavage:* {001}, perfect; {100}, {010}, fair. *Tenacity:* Fragile [*sic*], prone to smearing. Hardness = 3 D(meas.) = 3.09–3.15 D(calc.) = 3.23

Optical Properties: Semitransparent. *Color:* Brilliant dark red; brownish red on exposure. *Luster:* Adamantine, less brilliant after exposure.
Optical Class: Biaxial (–). *Pleochroism:* X = yellow; Y = yellow-orange; Z = red. *Orientation:* $Y = a$; $Z = b$; $X \wedge c \sim 5°$. $\alpha = 1.797$–1.80 $\beta = 2.01$–2.04 $\gamma = 2.04$–2.08 2V(meas.) = 60°

Cell Data: *Space Group:* $P2/m$. $a = 12.17(4)$ $b = 3.602(10)$ $c = 7.78(4)$ $\beta = 95°2(24)'$
Z = 1

X-ray Powder Pattern: Cactus Rat mines, Utah, USA.
7.90 (100), 3.12 (70), 3.45 (35), 12.2 (25), 2.27 (25), 1.800 (25), 2.92 (18)

Chemistry:

	(1)	(2)	(3)
V_2O_5	82.40	76.60	82.46
V_2O_4		6.26	
SiO_2	0.40		
CaO		3.84	
Na_2O	9.10	5.38	9.37
H_2O^+		5.20	
H_2O^-		2.72	
H_2O	7.73		8.17
Total	99.63	[100.00]	100.00

(1) Cactus Rat mines, Utah, USA. (2) Kazakhstan; recalculated to 100% after deduction of 9.14% impurities; corresponds to $(Na_{1.13}Ca_{0.45})_{\Sigma=1.58}(V_{5.51}^{5+}V_{0.49}^{4+})_{\Sigma=6.00}[O_{15.55}(OH)_{0.45}]_{\Sigma=16.00}\cdot 2.69H_2O$. (3) $Na_2V_6O_{16}\cdot 3H_2O$.

Occurrence: In small cavities and fractures and as interstitial filling in sandstone in the oxidized zone of a vanadiferous uranium deposit, possibly formed as an oxidation product of hewettite (Cactus Rat mines, Utah, USA); in weathered black schist (Kazakhstan).

Association: Metahewettite, thenardite (Cactus Rat mines, Utah, USA); bokite (The Fish, Nevada, USA); hewettite, metahewettite, jarosite, alunite, gypsum, barite (Kazakhstan).

Distribution: From the Cactus Rat mine group, Yellow Cat district, 24 km southeast of Thompson, Grand Co., Utah and The Fish, Eureka Co., Nevada, USA. In several mines of the Kurumsak and Balasauskandyk districts, northwestern Kara-Tau Mountains, Kazakhstan.

Name: To honor Dr. William H. Barnes (1903–), National Research Council of Canada, Ottawa, Canada, authority on the crystallography of many vanadium minerals.

Type Material: n.d.

References: (1) Weeks, A.D., D.R. Ross, and R.F. Marvin (1963) The occurrence and properties of barnesite, $Na_2V_6O_{16}\cdot 3H_2O$, a new hydrated sodium vanadate mineral from Utah. Amer. Mineral., 48, 1187–1195. (2) Evans, H.T., Jr. and J.M. Hughes (1990) Crystal chemistry of the natural vanadium bronzes. Amer. Mineral., 75, 508–521, esp. 514–515. (3) Akinovich, E.A. and N.I. Podlipaeva (1986) A Ca-variety of barnesite from rocks of a carbonaceous-siliceous vanadium-bearing formation in southern Kazakhstan. Zap. Vses. Mineral. Obshch., 115, 345–351.