

Philipsburgite

$(\text{Cu, Zn})_6(\text{AsO}_4, \text{PO}_4)_2(\text{OH})_6 \cdot \text{H}_2\text{O}$

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Crystal Data: Monoclinic. *Point Group:* $2/m$. Crystals are elongated along [010], with prominent {100}, bounded by {010}, {001}, {111}, may be curved, with chisel-shaped terminations, to 1 mm, typically in subparallel rosettes, spherules, and crusts.

Physical Properties: Hardness = 3–4 D(meas.) = 4.07(10) D(calc.) = 4.04

Optical Properties: Transparent to translucent. *Color:* Bright emerald-green. *Streak:* Pale green. *Luster:* Vitreous.

Optical Class: Biaxial (-). *Pleochroism:* Moderate; X = pale green; Y = Z = medium green.

Orientation: $Z = b$; $Y \wedge c = 7^\circ$. *Dispersion:* $r > v$, strong. *Absorption:* $Y = Z > X$.

$\alpha = 1.729(2)$ $\beta = 1.774(2)$ $\gamma = 1.775(2)$ $2V(\text{meas.}) = 16(2)^\circ$ $2V(\text{calc.}) = 17^\circ$

Cell Data: *Space Group:* $P2_1/c$. $a = 12.33(8)$ $b = 9.20(4)$ $c = 10.69(3)$ $\beta = 96.92(35)^\circ$
 $Z = 4$

X-ray Powder Pattern: Black Pine mine, Montana, USA.

2.559 (100), 4.05 (90), 12.2 (80), 2.666 (60), 1.534 (60), 3.405 (50), 6.21 (40)

Chemistry:

	(1)	(2)
P_2O_5	8.7	5.2
As_2O_5	16.3	25.5
CuO	46.3	51.4
ZnO	18.2	11.8
H_2O	9.9	
Total	99.4	

(1) Black Pine mine, Montana, USA; by electron microprobe, H_2O by TGA-EGA; corresponding to $(\text{Cu}_{4.30}\text{Zn}_{1.65})_{\Sigma=5.95}[(\text{AsO}_4)_{1.05}(\text{PO}_4)_{0.90}]_{\Sigma=1.95}(\text{OH})_{6.03} \cdot 1.04\text{H}_2\text{O}$. (2) Potts Gill mine, England; by electron microprobe, partial analysis; corresponds to $(\text{Cu}_{4.92}\text{Zn}_{1.08})_{\Sigma=6.00}[(\text{AsO}_4)_{1.48}(\text{PO}_4)_{0.52}]_{\Sigma=2.00}(\text{OH})_6 \cdot \text{H}_2\text{O}$.

Occurrence: A rare secondary mineral in the oxidized zone of hydrothermal base-metal deposits.

Association: Bayldonite, chrysocolla, mimetite, quartz (Black Pine mine, Montana, USA); cornwallite, bayldonite, mimetite, malachite (Potts Gill mine, England).

Distribution: In the USA, from the Black Pine mine, about 14.5 km northwest of Philipsburg, Granite Co., Montana; large crystals in the Gold Hill mine, Tooele Co., and in the Centennial Eureka mine, Tintic district, Juab Co., Utah. In England, at the Potts Gill mine and the Low Pike vein, Caldbeck Fells, Cumbria; from Wheal Carpenter, Gwinear, and the Penberthy Croft mine, St. Hilary, Cornwall. At the Clara mine, near Oberwolfach, Black Forest, and from Schwarzenberg, Saxony, Germany. From Brixlegg, Tirol, Austria. In the Sa Duchessa mine, Oridda district, Sardinia, Italy. At the Christiana mine, Kamariza district, Laurium, Greece.

Name: For the town of Philipsburg, Montana, USA, near which the mineral was first found.

Type Material: Royal Ontario Museum, Toronto, Canada, M41000; National Museum of Natural History, Washington, D.C., USA, 161201.

References: (1) Peacor, D.R., P.J. Dunn, R.A. Ramik, B.D. Sturman, and L.G. Zeihen (1985) Philipsburgite, a new copper zinc arsenate hydrate related to kipushite, from Montana. *Can. Mineral.*, 23, 255–258. (2) (1986) *Amer. Mineral.*, 71, 1279 (abs. ref. 1). (3) Braithwaite, R.S.W. and G. Ryback (1988) Philipsburgite from the Caldbeck Fells and kipushite from Montana, and their infrared spectra. *Mineral. Mag.*, 52, 529–533. (4) Kokinos, M. and W.S. Wise (1993) The Gold Hill mine, Tooele County, Utah. *Mineral. Record*, 24, 11–22.

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