

## Pennantite

 $\text{Mn}_5^{2+}\text{Al}(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$ 

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**Crystal Data:** Triclinic. *Point Group:*  $\bar{1}$  or 1. As lamellar crystals and flakes, to 0.5 mm; in grains and platy aggregates, sometimes forming rosettelike clusters.

**Physical Properties:** *Cleavage:* {001}, perfect. *Tenacity:* Flexible, inelastic. Hardness = 2–2.5 D(meas.) = 2.89–3.07 D(calc.) = [3.18]

**Optical Properties:** Translucent to nearly opaque. *Color:* Orange-brown, reddish brown, brown, dark red, dark green, black; in transmitted light, orange, pinkish, reddish orange.

*Luster:* Pearly on cleavage faces.

*Optical Class:* Biaxial (–). *Pleochroism:* X = pinkish orange, orange-buff, reddish brown; Y = Z = orange, yellowish orange, very dark brown. *Absorption:* Y = Z > X.  $\alpha = 1.615\text{--}1.664$   
 $\beta = \text{n.d.}$   $\gamma = 1.622\text{--}1.673$  2V(meas.) = 0° to very small.

**Cell Data:** *Space Group:*  $C\bar{1}$  or C1.  $a = 5.45$   $b = 9.50$   $c = 14.40$   $\alpha = 90.0^\circ$   
 $\beta = 97.3^\circ$   $\gamma = 90.0^\circ$  Z = 2

**X-ray Powder Pattern:** Benallt mine, Wales.

7.1 (100), 3.57 (80), 2.43 (80), 14.3 (40), 2.70 (40), 2.03 (40), 4.75 (30)

Chemistry:	(1)	(2)	(3)	(1)	(2)	(3)
SiO <sub>2</sub>	22.64	21.29	23.9	ZnO	0.97	15.9
Al <sub>2</sub> O <sub>3</sub>	18.60	19.07	19.1	MgO	[1.48]	3.4
Fe <sub>2</sub> O <sub>3</sub>	4.43	6.67	2.6	BaO	1.33	0.00
MnO	38.93	39.82	27.4	H <sub>2</sub> O	[9.40]	[7.7]
				Total	[96.81]	99.93 [100.0]

(1) Benallt mine, Wales; MgO and H<sub>2</sub>O determined on an impure sample; corresponds to  $(\text{Mn}_{3.92}\text{Al}_{1.32}\text{Fe}_{0.39}^{3+}\text{Mg}_{0.26}\text{Ba}_{0.08})_{\Sigma=5.97}(\text{Si}_{2.70}\text{Al}_{1.30})_{\Sigma=4.00}\text{O}_{10}(\text{OH})_{8.00}$ . (2) Ushkatyn deposit, Kazakhstan; corresponds to  $(\text{Mn}_{4.00}\text{Al}_{1.31}\text{Fe}_{0.60}^{3+}\text{Zn}_{0.09})_{\Sigma=6.00}(\text{Si}_{2.59}\text{Al}_{1.41})_{\Sigma=4.00}\text{O}_{10}[(\text{OH})_{7.51}\text{O}_{0.49}]_{\Sigma=8.00}$ . (3) Franklin, New Jersey, USA; by electron microprobe, total Fe as Fe<sub>2</sub>O<sub>3</sub>, H<sub>2</sub>O by difference; corresponds to  $(\text{Mn}_{2.6}\text{Zn}_{1.3}\text{Al}_{1.3}\text{Mg}_{0.6}\text{Fe}_{0.2}^{3+})_{\Sigma=6.0}(\text{Si}_{2.7}\text{Al}_{1.3})_{\Sigma=4.0}\text{O}_{10}(\text{OH})_8$ .

**Mineral Group:** Chlorite group.

**Occurrence:** Formed during hydrothermal alteration of manganese deposits, as crusts on manganese minerals, and in veins cutting ore.

**Association:** Banalsite, analcime, paragonite, pyrophanite, garnet, barite, ganophyllite, kutnohorite, kellyite, willemite, prehnite, datolite, roebingite, clinohedrite, hancockite, friedelite.

**Distribution:** In the Benallt mine, Rhiw, Lleyen Peninsula, Wales. From the Ushkatyn and Dzhumart deposits, Atasu district, Kazakhstan. In the Harstigen mine, near Persberg, Värmland, Sweden. At Bald Knob, near Sparta, Alleghany Co., North Carolina, and Franklin, Sussex Co., New Jersey, USA.

**Name:** For the Welsh mineralogist Thomas Pennant (1726–1798).

**Type Material:** The Natural History Museum, London, England, 1947,295–296; Harvard University, Cambridge, Massachusetts, 104705; National Museum of Natural History, Washington, D.C., USA, 105855.

**References:** (1) Smith, W.C., F.A. Bannister, and M.H. Hey (1946) Pennantite, a new manganese-rich chlorite from Benallt mine, Rhiw, Carnarvonshire. *Mineral. Mag.*, 27, 217–220. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) *Rock-forming minerals*, v. 3, sheet silicates, 131–163. (3) Kayupova, M.M. (1965) Pennantite from the Ushkatyn deposit, central Kazakhstan. *Doklady Acad. Nauk SSSR*, 163, 189–192 (in Russian). (4) (1965) *Chem. Abs.*, 63, 11176 (abs. ref. 3). (5) Peacor, D.R., E.J. Essene, W.B. Simmons, Jr., and W.C. Bigelow (1974) Kellyite, a new Mn-Al member of the serpentine group from Bald Knob, North Carolina, and new data on grovesite. *Amer. Mineral.*, 59, 1153–1156. (6) Bayliss, P. (1983) Polytypes of pennantite. *Can. Mineral.*, 21, 545–547.

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