

**Wardite****NaAl<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>(OH)<sub>4</sub>•2H<sub>2</sub>O**

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**Crystal Data:** Tetragonal. *Point Group:* 422. Dipyramidal pseudo-octahedral crystals, with {010}, {011}, {012}, {100}, rarely {001}, typically striated  $\perp$  [001], to 4 cm.

**Physical Properties:** *Cleavage:* On {001}, perfect. Hardness = 5 D(meas.) = 2.81–2.87 D(calc.) = 2.805

**Optical Properties:** Transparent to opaque. *Color:* White, colorless, pale green, blue-green, yellow-green, pale yellow, brown; colorless in transmitted light. *Luster:* Vitreous.

*Optical Class:* Uniaxial (+).  $\omega = 1.586\text{--}1.594$   $\epsilon = 1.595\text{--}1.604$

**Cell Data:** *Space Group:*  $P4_12_12$  or  $P4_32_12$ .  $a = 7.03(1)$   $c = 19.04(1)$   $Z = 4$

**X-ray Powder Pattern:** [Palermo #1 mine, New Hampshire, USA]. 4.74 (10), 2.994 (7), 2.591 (7), 3.085 (6), 1.516 (5), 2.825 (4), 2.108 (4)

**Chemistry:**

	(1)	(2)
P <sub>2</sub> O <sub>5</sub>	35.12	35.67
Al <sub>2</sub> O <sub>3</sub>	38.70	38.43
FeO	0.26	
MgO	0.21	
Na <sub>2</sub> O	7.51	7.79
K <sub>2</sub> O	0.16	
H <sub>2</sub> O	17.88	18.11
Total	99.84	100.00

(1) [Palermo #1 mine, New Hampshire,] USA. (2) NaAl<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>(OH)<sub>4</sub>•2H<sub>2</sub>O.

**Occurrence:** A component of low-temperature phosphatic nodules; an uncommon species in complex zoned pegmatites.

**Association:** Variscite, millisite, crandallite (Little Green Monster mine, Utah, USA); ferrisicklerite, mitridatite, whitlockite, montgomeryite, fairfieldite, hydroxyl-herderite, eosphorite, siderite roscherite (pegmatites).

**Distribution:** In the USA, from the Little Green Monster mine, Clay Canyon, about nine km west of Fairfield, Utah Co., Utah; in Maine, at the Dunton quarry and the Bell Pit, Newry; at the Palermo #1 mine, North Groton, Grafton Co., New Hampshire; in the Hugo pegmatite, near Keystone, Pennington Co., and the Tip Top mine, 8.5 km southwest of Custer, Custer Co., South Dakota. Large crystals from the Big Fish River–Rapid Creek area, Yukon Territory, Canada. In Brazil, from the Lavra da Ilha pegmatite, in the Jequitinhonha River, three km north of Taquaral, and in the Pirineus mine, Itinga, Minas Gerais; at Alto Patrimônio, Pedras Lavradas, Paraíba. From Songo, Sierra Leone. At the Wolfsberg quarry, near Spittal, Carinthia, Austria. In France, from Ruffiac, Morbihan, and Montebrias, Creuse. At the Iron Monarch quarry, Iron Knob, South Australia, from Wycheproof, Victoria, and on Milgun Station, Western Australia. A few other localities are known.

**Name:** Honoring Henry Augustus Ward (1834–1906), American collector and dealer in natural history objects (Ward's Natural Science Establishment) Rochester, New York, USA.

**Type Material:** n.d.

**References:** (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 940–941. (2) Fanfani, L., A. Nunzi, and P.F. Zanazzi (1970) The crystal structure of wardite. *Mineral. Mag.*, 37, 598–605. (3) Lindberg, M.L. (1957) Relationship of the minerals avelinoite, cyrilovite, and wardite. *Amer. Mineral.*, 42, 204–213.

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