Fluorowardite $NaAl_3(PO_4)_2(OH)_2F_2 \cdot 2H_2O$

Crystal Data: Tetragonal. *Point Group*: 422. As tetragonal bipyramidal crystals, to 0.1 mm, displaying {001} (prominent and lustrous), {011} and/or {012} (prominent, irregular, and striated parallel to [100]), and {100} (common, irregular, and striated parallel to [100]).

Physical Properties: *Cleavage*: Perfect on {001}. *Fracture*: Irregular. *Tenacity*: Brittle. Hardness = 5 D(meas.) = n.d. D(calc.) = 2.706

Optical Properties: Transparent to translucent. *Color*: Colorless to white or cream-colored. *Streak*: White. *Luster*: Vitreous to pearly.
Optical Class: Uniaxial (+). ω = 1.576(2) ε = 1.584(2)

Cell Data: *Space Group*: $P4_12_12$. a = 7.077(2) c = 19.227(3) Z = 4

X-ray Powder Pattern: Silver Coin mine, Valmy, Humboldt County, Nevada, USA.
4.766 (100), 3.099 (75), 3.008 (62), 2.597 (56), 1.5228 (49), 1.7628 (32), 1.6592 (29)

Chemistry:	(1)	(2)
Na_2O	6.27	7.71
CaO	1.74	
MgO	0.42	
Al_2O_3	35.21	38.05
Fe_2O_3	0.72	
P_2O_5	32.49	35.32
As_2O_5	0.64	
F	6.76	9.45
$-O = F_2$	2.85	3.98
H_2O	[13.35]	13.45
total	94.74	100.00

(1) Silver Coin mine, Valmy, Humboldt County, Nevada, USA; average of 8 electron microprobe analyses supplemented by FTIR and Raman spectroscopy, H_2O calculated from the structure; corresponds to $(Na_{0.87}Ca_{0.13}Mg_{0.04})_{\Sigma=1.04}(Al_{2.96}Fe^{3+}_{0.04})_{\Sigma=3.00}(P_{1.96}As_{0.03})_{\Sigma=1.99}O_{8.12}(OH)_{2.35}F_{1.53} \cdot 2H_2O$.
(2) $NaAl_3(PO_4)_2(OH)_2F_2 \cdot 2H_2O$.

Occurrence: A secondary phase, in a F-rich secondary phosphate assemblage.

Association: Alunite, barite, cacoxenite, chlorargyrite, fluorapatite, goethite, gorceixite (F-rich), iangreyite, iodargyrite, jarosite, kidwellite, kintoreite/plumbogummite, krásnoite, leucophosphite, lipscombite/zinclipscombite, meurigite-Na, metavariscite, millisite (F-rich), morinite, quartz, rockbridgeite, strengite/variscite, turquoise/chalcosiderite. Minerals separated by slashes exhibit variations in chemistry between the two species.

Distribution: From the phosphate stope, Silver Coin mine, Valmy, Iron Point district, Humboldt County, Nevada, USA.

Name: The fluorine analog of wardite; with the prefix “fluoro-” rather than “fluor-” to make pronunciation more straightforward.

Type Material: Mineral Sciences Department, Natural History Museum of Los Angeles County, Los Angeles, California, USA (57659 and 63810).

References: (1) Kampf, A.R., P.M. Adams, R.M. Housley, and G.R. Rossman (2014) Fluorowardite, $NaAl_3(PO_4)_2(OH)_2F_2 \cdot 2H_2O$, the fluorine analog of wardite from the Silver Coin mine, Valmy, Nevada. Amer. Mineral., 99, 804-810.