Esperanzaite $NaCa_2Al_2(AsO_4)_2F_4(OH)\cdot 2H_2O$

Crystal Data: Monoclinic. *Point Group:* $2/m$. As radiating crystals, in spherulites, to 1.5 mm, which may form botryoidal aggregates.

Physical Properties: *Cleavage:* One, perfect, ‖ [001]. *Tenacity:* Brittle. Hardness = 4.5 D(meas.) = 3.24 D(calc.) = 3.36(3)

Optical Properties: Transparent to translucent. *Color:* Pale blue-green; colorless in transmitted ight. *Streak:* White. *Luster:* Vitreous.
Optical Class: Biaxial (–). *Orientation:* $Y = b$; $X \wedge c = 35°$; $Z \wedge a = 50.5°$. *Dispersion:* $r < v$, medium. $\alpha = 1.580(1)$ $\beta = 1.588(1)$ $\gamma = 1.593(1)$ 2V(meas.) = 74(1)° 2V(calc.) = 76.3°

Cell Data: *Space Group:* $P2_1/m$. $a = 9.687(5)$ $b = 10.7379(6)$ $c = 5.5523(7)$ $\beta = 105.32(1)°$ Z = 2

X-ray Powder Pattern: La Esperanza mine, Mexico.
2.966 (100), 3.527 (90), 2.700 (90b), 5.364 (80), 4.796 (80), 3.801 (80), 2.246 (60)

Chemistry:

	(1)	(2)
As_2O_5	40.67	40.75
Al_2O_3	19.20	18.08
ZnO	0.87	
CaO	20.75	19.89
Na_2O	3.86	5.49
F	13.9	13.47
H_2O	8.65	7.99
$-O = F_2$	5.83	5.67
Total	102.07	100.00

(1) La Esperanza mine, Mexico; by electron microprobe, average of three analyses on two grains; H_2O by Karl Fischer coulometric titration; $(AsO_4)^{3-}$, $(OH)^{1-}$, H_2O confirmed by IR; calculated from an original analysis As 26.50%, Al 10.16%, Zn 0.70%, Ca 14.83%, Na 2.86%, F 13.9%, H_2O 8.65%, O 24.45% calculated for charge balance, total 102.15%; corresponds to $Na_{0.68}Ca_{2.03}Zn_{0.07}Al_{2.06}(As_{0.97}O_{3.94})_2F_{4.00}(OH)\cdot 2.13H_2O$. (2) $NaCa_2Al_2(AsO_4)_2F_4(OH)\cdot 2H_2O$.

Occurrence: Very rare from a tin-bearing rhyolite.

Association: Hematite, cassiterite, quartz, tridymite, cristobalite, "opal", calcite, zeolites, mimetite, clay minerals.

Distribution: From the La Esperanza mine, 3.7 km southeast of Madero, Zaragosa district, Durango, Mexico.

Name: For the La Esperanza mine, Mexico, from which the mineral was collected.

Type Material: National Museum of Natural History, Washington, D.C., USA, 171530.

References: (1) Foord, E.E., J.M. Hughes, F. Cureton, C.H. Maxwell, A.U. Falster, A.J. Sommer, and P.F. Hlava (1999) Esperanzaite, $NaCa_2Al_2(As^{5+}O_4)_2F_4(OH)\cdot 2H_2O$, a new mineral species from the La Esperanza mine, Mexico: descriptive mineralogy and atomic arrangement. Can. Mineral., 37, 67–72. (2) (2000) Amer. Mineral., 85, 263 (abs. ref. 1).