Espadaite $Na_4Ca_3Mg_2[AsO_3(OH)]_2[AsO_2(OH)_2]_{10}(H_2O)_6 \cdot H_2O$

Crystal Data: Orthorhombic. *Point Group*: 2/*m* 2/*m* 2/*m*. As blades to ~0.2 mm forming fans, jumbled sprays, and random intergrowths. Blades are flattened on {001}, elongate along [100] and exhibit {001}, {010}, {110}, and {111}.

Physical Properties: *Cleavage*: Perfect on {001}. *Tenacity*: Brittle. *Fracture*: Curved. Hardness = ~2 D(meas.) = 2.73(2) D(calc.) = 2.730 Easily soluble in dilute HCl.

Optical Properties: Transparent. *Color*: Colorless. *Streak*: White. *Luster*: Vitreous. *Optical Class*: Biaxial (-). α = 1.531(1) β = 1.568(1) γ = 1.574(1) 2V(meas.) = 44(1)° 2V(calc.) = 43.0° *Orientation*: *X* = *c*, *Y* = *a*, *Z* = *b*. *Dispersion*: Very slight, *r* < *v*. Nonpleochroic.

Cell Data: *Space Group*: *Ccca*. *a* = 12.3649(10) *b* = 22.181(2) *c* = 18.3292(13) Z = 4

X-Ray Diffraction Pattern: Torrecillas mine, Iquique Province, Tarapacá Region, Chile. 9.26 (100), 3.499 (80), 3.068 (79), 4.118 (73), 4.582 (49), 2.766 (39), 2.710 (39)

Chemistry:

	(1)	(2)
Na_2O	4.39	[4.95]
CaO	7.89	8.15
MgO	4.24	4.38
As_2O_5	64.60	66.74
H_2O	n.d.	[15.78]
Total		100.00

(1) Torrecillas mine, Iquique Province, Tarapacá Region, Chile; average electron microprobe analysis supplemented by Raman spectroscopy. (2) Do.; average electron microprobe analysis supplemented by Raman spectroscopy, Na_2O and H_2O calculated from structure; normalized corresponds to $(Na_{0.83}Mg_{0.06}\square_{0.11})_4Ca_{3.00}Mg_{2.00}[AsO_3OH]_{1.80}[AsO_2(OH)_2]_{10.20}(H_2O)_6 \cdot H_2O$.

Occurance: A low-temperature secondary phase on massive quartz-hematite veins and formed under hyperarid conditions from the oxidation of native arsenic, and possibly other As-bearing primary phases by reaction with fluids (derived from fog) rich in dissolved Na, Ca, and Mg.

Association: Camanchacaite, anhydrite, gypsum, halite, talmessite.

Distribution: From the Torrecillas mine, northern Atacama Desert, Salar Grande, Iquique Province, Tarapacá Region, Chile.

Name: From the Spanish, *espada*, for 'sword', in allusion to the shape of the crystals.

Type Material: Natural History Museum of Los Angeles County, Los Angeles, California, USA (67285).

References: (1) Kampf, A.R., B.P. Nash, A.J. Celestian, M. Dini, and A.A. Molina Donoso (2019) Camanchacaite, chinchorroite, espadaite, magnesiofluckite, picaite and ríosecoite: six new hydrogen-arsenate minerals from the Torrecillas mine, Iquique Province, Chile. Mineral. Mag., 83, 655-671.