

Arrojadite-(BaNa)**BaNa₃(Na, Ca)Fe²⁺₁₃Al(PO₄)₁₁(PO₃OH)(OH)₂**

Crystal Data: Monoclinic. *Point Group:* 2/m or m. As rounded masses or roughly crystallized individuals to 5 cm. As tabular platy crystals to 1 mm.

Physical Properties: *Cleavage:* Good on {110}. *Tenacity:* Brittle. *Fracture:* Irregular. Hardness = 4-5 D(meas.) = 3.54(2) D(calc.) = 3.76 (Luna); 3.620 and 3.710 (Big Fish River)

Optical Properties: Translucent. *Color:* Pale grayish green; pale yellowish brown when altered; colorless, light to medium gray. *Streak:* White. *Luster:* Greasy to vitreous.

Optical Class: Biaxial (+). $\alpha = 1.656(2)$ $\beta = 1.660(2)$ $\gamma = 1.664(2)$ $2V(\text{meas.}) = 44(1)^\circ$ $2V(\text{calc.}) = 45^\circ$ *Dispersion:* Intermediate. *Orientation:* OAP \perp to {110}; $Z \wedge c = 17-18^\circ$.

Cell Data: *Space Group:* C2/c. $a = 16.4984(6)$ $b = 10.0228(1)$ $c = 24.648(1)$ $\beta = 105.850(4)^\circ$ $Z = 4$ (Luna); Cc . $a = 16.5163(8)$ $b = 10.0067(5)$ $c = 24.5435(12)$ $\beta = 106.121(2)^\circ$ $Z = 4$ (Big Fish)

X-ray Powder Pattern: Luna albite pegmatite, Dorio, Lecco province, Italy. 3.137 (100), 2.818 (61), 3.303 (46), 2.667 (35), 2.878 (32), 3.488 (28), 4.621 (22)

Chemistry:	(1)	(2)	(3)		(1)	(2)	(3)
P ₂ O ₅	39.73	39.72	39.84	CaO	2.22	1.29	2.16
Al ₂ O ₃	2.40	2.35	2.61	Na ₂ O	6.06	5.72	5.77
FeO	32.91	43.06	34.87	K ₂ O	0.59		
MnO	5.41		1.97	H ₂ O ⁺	[0.42]		
MgO	3.60		3.89	H ₂ O ⁻	[0.70]	1.25	1.26
PbO	1.35			F	0.22		
BaO	4.43	7.07	7.27	<u>-O = (F,Cl)₂</u>	<u>0.09</u>		
SrO	0.35			Total	100.30	100.00	99.63

(1) Luna albite pegmatite, Dorio, Italy; average electron microprobe analysis supplemented by Raman spectroscopy, H₂O⁺ calculated from stoichiometry, H₂O⁻ calculated for 2 = OH+F+Cl pfu; corresponds to (Ba_{0.62}K_{0.27}Pb_{0.13}Sr_{0.07}) $\Sigma=1.09$ Na₃(Na_{1.19}Ca_{0.85}) $\Sigma=2.04$ (Fe²⁺_{9.82}Mg_{1.92}Mn²⁺_{1.64}) $\Sigma=13.38$ Al_{1.01}(PO₄)₁₁(PO₃OH)[(OH)_{1.75}F_{0.25}] $\Sigma=2$. (2) BaNa₃(Na,Ca)Fe²⁺₁₃Al(PO₄)₁₁(PO₃OH)(OH)₂. (3) Big Fish River, Yukon Territory, Canada; average electron microprobe analysis and Raman spectroscopy; corresponds to Ba_{1.01}Na_{1.98}Ca_{0.82}Na_{2.0}(Fe²⁺_{10.37}Mg_{2.06}Mn_{0.59}) $\Sigma=13.03$ Al_{1.10}(PO₄)₁₁(PO₃OH)(OH)_{2.00}.

Mineral Group: Arrojadite group. A₂B₂CaNa_{2+x}M₁₃Al(PO₄)₁₁(PO₃OH_{1-x})W₂.

Occurrence: A primary mineral in the blocky-plagioclase zone of a granitic pegmatite. Product of very low-grade metamorphism of phosphatic ironstone shales and mudstones (Big Fish River).

Association: Fluorapatite, albite (Luna); arrojadite-(KNa), satterlyite, gormanite, apatite/'francolite', siderite, quartz, pyrite (Big Fish).

Distribution: From the Luna albite pegmatite, Dorio, Lecco province, Italy [TL] and Big Fish River, Yukon Territory, Canada.

Name: *Arrojadite* indicates a member of the group with Fe²⁺ dominant at the M site; two suffixes indicate the dominant cation of the dominant valence state at the A and B sites. Honors Miguel Arrojado Ribeiro Lisbôa (1872-1932), Brazilian geologist.

Type Material: Natural History Museum, Milan, Italy (38718); Laboratory of Mineralogy, University of Liege, Belgium (20391); National Museum of Natural History, Washington, D.C., USA; and Department of Geology and Petrography, Moravian Museum, Brno, Czech Republic.

References: (1) Vignola, P., F. Hatert, M. Baijot, F. Dal Bo, S. Andò, D. Bersani, A. Pavese, A. Risplendente, and F. Vanini (2016) Arrojadite-(BaNa), BaNa₃(Na,Ca)Fe²⁺₁₃Al(PO₄)₁₁(PO₃OH)(OH)₂, a new phosphate mineral from the Luna albite pegmatite, Dorio commune, Lecco province, Italy. *Can. Mineral.*, 54, 1021-1032. (2) (2018) *Amer. Mineral.*, 103, 331 (abs. ref. 1 and comment). (3) Tomes, H.E., V.E. Di Cecco, K.T. Tait, and F. Cámara (2018) Crystal structure of near-endmember arrojadite-(BaNa) from Big River, Yukon, Canada. *Can. Mineral.*, 56, 923-938.