

**Arrojadite-(KNa)** **$\text{KNa}_3(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}(\text{PO}_4)_{11}(\text{PO}_3\text{OH})(\text{OH})_2$** 

**Crystal Data:** Monoclinic. *Point Group:* *m*. As stout platy prisms to several mm.

**Physical Properties:** *Cleavage:* On {001}. *Tenacity:* Brittle. *Fracture:* n.d. *Hardness* = 3.5-4  
D(meas.) = n.d. D(calc.) = 2.84 Nonfluorescent.

**Optical Properties:** Transparent. *Color:* Yellow. *Streak:* White. *Luster:* Vitreous.  
*Optical Class:* Biaxial (+).  $\alpha = 1.651(1)$   $\beta = 1.656(1)$   $\gamma = 1.662(10)$   $2V(\text{meas.}) = 87.8(1)^\circ$   
 $2V(\text{calc.}) = 85^\circ$  *Dispersion:*  $r \ll v$ . *Orientation:*  $X = b$ ,  $Y \approx c$ . *Absorption:*  $Y < X \approx Z$ .  
*Pleochroism:* Very weak,  $Y = \text{colorless}$ ,  $Z = \text{pale yellow}$ .

**Cell Data:** *Space Group:* *Cc*.  $a = 16.5220(11)$   $b = 10.0529(7)$   $c = 24.6477(16)$   $\beta = 106.509(2)^\circ$   $Z = 4$

**X-Ray Diffraction Pattern:** Calculated pattern.  
3.05 (100), 2.691 (71), 3.186 (34), 5.861 (29), 5.026 (28), 2.793 (28), 2.798 (25)

<b>Chemistry:</b>	(1)	(2)	(3)		(1)	(2)	(3)
P <sub>2</sub> O <sub>5</sub>	41.20	[40.25]	40.14	SrO	0.03	0.02	
Al <sub>2</sub> O <sub>3</sub>	2.56	2.40	2.40	BaO	0.02	0.13	
FeO	32.40	37.76	44.02	PbO	0.03	0.05	
MnO	3.54	4.40		F	0.02	0.33	
ZnO	0.04	0.16		H <sub>2</sub> O	[1.31]	[1.12]	1.27
MgO	5.23	1.28		<u>-O = F</u>	<u>0.01</u>	<u>0.14</u>	<u>_____</u>
Li <sub>2</sub> O <sub>LAM</sub>	0.005	0.001		Total	98.35	99.40	100.00
Na <sub>2</sub> O	7.50	6.89	7.31				
K <sub>2</sub> O	1.90	1.92	2.22				
CaO	2.48	2.70	2.64				

(1) Rapid Creek, Yukon Territory, Canada; average electron microprobe analysis, H<sub>2</sub>O and P<sub>2</sub>O<sub>5</sub> calculated; corresponds to  $\text{K}_{0.83}\text{Na}_{5.01}(\text{Ca}_{0.91}\text{Sr}_{0.01})_{\Sigma=0.92}(\text{Fe}^{2+}_{9.34}\text{Mg}_{2.69}\text{Mn}^{2+}_{1.03}\text{Zn}_{0.01}\text{Li}_{0.01})_{\Sigma=13.08}(\text{Al}_{1.04}\text{Ti}_{0.02})_{\Sigma=1.06}[(\text{OH})_{1.97}\text{F}_{0.03}]_{\Sigma=2.00}(\text{P}_{11.99}\text{Si}_{0.01})\text{O}_{47}(\text{OH})_{1.00}$ . (2) Victory mine, South Dakota, USA; average electron microprobe analysis, H<sub>2</sub>O and P<sub>2</sub>O<sub>5</sub> calculated. (3)  $\text{KNa}_3(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}(\text{PO}_4)_{11}(\text{PO}_3\text{OH})(\text{OH})_2$ .

**Polymorphism & Series:** Forms a series with dickinsonite.

**Mineral Group:** Arrojadite group.  $\text{A}_2\text{B}_2\text{CaNa}_{2+x}\text{M}_{13}\text{Al}(\text{PO}_4)_{11}(\text{PO}_3\text{OH}_{1-x})\text{W}_2$ .

**Occurrence:** Along veins in sandstone formed during very low-grade metamorphism.

**Association:** Lazulite, hematite, fluorapatite, quartz.

**Distribution:** From the Yukon Territory, Canada [TL] and the Victory Mine, South Dakota, USA. In the Mount Wills pegmatite field, Victoria, Australia.

**Name:** *Arrojadite* indicates a member of the group with Fe<sup>2+</sup> 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:** Mineral Museum, School of Mines, Paris, France (41081).

**References:** (1) Chopin, C., R. Oberti, and F. Cámara (2006) The arrojadite enigma: II. Compositional space, new members, and nomenclature of the group. *Amer. Mineral.*, 91, 1260-1270. (2) Cámara, F., R. Oberti, C. Chopin, and O. Medenbach (2006) The arrojadite enigma: I. A new formula and a new model for the arrojadite structure. *Amer. Mineral.*, 91, 1249-1259. (3) Birch, W.D. (2018) Minerals in the arrojadite, alluaudite and jahnsite-whiteite groups from the Mount Wills pegmatite field, Victoria, Australia. *Eur. J. Mineral.*, 30, 635-645.