

Kulanite**Ba(Fe²⁺, Mn, Mg)₂Al₂(PO₄)₃(OH)₃**

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Crystal Data: Monoclinic. *Point Group:* 2/*m*. As plates, to 1.5 cm, tabular on { $\bar{1}01$ }, with {10 $\bar{1}$ }, {100}, {001}, {011}, {161}, several others; aggregated in rosettes. Commonly in zoned intergrowth with penikisite.

Physical Properties: *Cleavage:* Fair to good on {010} and {100}. *Hardness* = ~ 4
D(meas.) = 3.91(3) D(calc.) = 3.92

Optical Properties: Transparent to translucent. *Color:* Green to blue. *Streak:* Very pale green. *Luster:* Vitreous.

Optical Class: Biaxial (+). *Pleochroism:* X = brownish green; Y = green; Z = very pale brown. *Orientation:* Y $\simeq$ b; Z $\wedge$ c = -8° . *Dispersion:* $r \gg v$, very strong and asymmetrical, suggesting a triclinic structure. *Absorption:* X $\simeq$ Y $\gg$ Z. $\alpha = 1.703$ $\beta = 1.705$ $\gamma = 1.723$
2V(meas.) = 32° 2V(calc.) = 38°

Cell Data: *Space Group:* P2₁/*m*. $a = 9.014(1)$ $b = 12.074(1)$ $c = 4.926(1)$
 $\beta = 100.48(1)^\circ$ Z = 2

X-ray Powder Pattern: Cross-cut Creek, Canada; almost identical to penikisite.
3.108 (100), 2.927 (80), 3.044 (70), 2.659 (70), 8.84 (60), 2.690 (60), 4.51 (50)

Chemistry:	(1)	(2)		(1)	(2)
P ₂ O ₅	33.28	33.80	MgO	3.08	3.89
SiO ₂	0.19		CaO	0.77	0.42
Al ₂ O ₃	14.30	15.06	BaO	23.66	24.99
Fe ₂ O ₃	2.14	1.61	Na ₂ O	0.02	
FeO	10.50	13.47	H ₂ O ⁺	3.83	[4.27]
MnO	6.32	0.95	Total	98.09	[98.46]

(1) Cross-cut Creek, Canada; H₂O by DTA-TGA, corresponding to Ba_{1.00}(Fe_{0.94}²⁺Mn_{0.58}Mg_{0.50}Ca_{0.09})_{Σ=2.11}(Al_{1.81}Fe_{0.18}³⁺)_{Σ=1.99}(PO₄)_{3.02}(OH)_{2.74}. (2) Do.; by electron microprobe, average of ten analyses, Fe²⁺:Fe³⁺ ratio and H₂O from structure analysis; corresponding to Ba_{1.03}(Fe_{1.19}²⁺Mg_{0.61}Mn_{0.08})_{Σ=1.88}Al_{1.87}(PO₄)_{3.02}(OH)₃.

Polymorphism & Series: Forms a series with penikisite.

Mineral Group: Bjarebyte group.

Occurrence: A weathering product in fractures in sideritic iron formation (Cross-cut Creek, Canada); as disseminations and veinlets in granite pegmatite (Xiyuantou, China).

Association: Penikisite, quartz, siderite, fluorapatite, rapidcreekite, brazilianite, arrojadite, anatase, goyazite (Cross-cut Creek, Canada); palermoite, montebrasite, triphylite (Palermo #1 mine, New Hampshire, USA).

Distribution: From Cross-cut Creek, 1.5 km upstream from the confluence with Rapid Creek, Big Fish-Blow River area, Yukon Territory, Canada. In the White Picacho district, Maricopa and Yavapai Cos., Arizona, and at the Palermo #1 mine, North Groton, Grafton Co., New Hampshire, USA. From the Xiyuantou pegmatite, Nanping, Fujian Province, China.

Name: Honors Mr. Alan Kulan, Ross River, Yukon Territory, Canada, a co-discoverer of the Rapid Creek phosphate occurrences.

Type Material: Royal Ontario Museum, Toronto, Canada, M34170; National Museum of Natural History, Washington, D.C., USA, 137304, 145737.

References: (1) Mandarino, J.A. and B.D. Sturman (1976) Kulanite, a new barium iron aluminum phosphate from the Yukon Territory, Canada. *Can. Mineral.*, 14, 127–131. (2) (1977) *Amer. Mineral.*, 62, 174 (abs. ref. 1). (3) Cooper, M. and F.C. Hawthorne (1994) Refinement of the crystal structure of kulanite. *Can. Mineral.*, 32, 15–19. (4) Yeuqing Yang, Yunxiang Ni, Yongquan Guo, Yaping Zhang, and Jiapin Liu (1986) First discovery of kulanite in China. *Yanshi Kuangwuxue Zashi*, 5, 119–127 (in Chinese with English abstract). (5) (1990) *Amer. Mineral.*, 75, 245–246 (abs. ref. 4).

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