Kotoite $Mg_3(BO_3)_2$

Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. Granular massive. *Twinning:* On {101}, polysynthetic.

Physical Properties: *Cleavage:* On {110}, perfect; a parting on {101}. Hardness = 6.5 D(meas.) = 3.10 D(calc.) = 3.09

Optical Properties: Transparent. *Color:* Colorless to white. *Luster:* Vitreous. *Optical Class:* Biaxial (+). *Orientation:* $X = a$; $Y = b$; $Z = c$. *Dispersion:* $r > v$. $\alpha = 1.652$ $\beta = 1.653$ $\gamma = 1.673$–1.674 2V(meas.) = 21°–22°

Cell Data: *Space Group:* *Pnmn*. $a = 5.401$ $b = 8.422$ $c = 4.507$ Z = 2

X-ray Powder Pattern: Synthetic.
2.67 (100), 2.23 (100), 2.18 (100), 1.73 (100), 1.67 (100), 1.51 (100), 3.47 (75)

Chemistry:

	(1)	(2)
SiO_2	1.32	
B_2O_3	35.20	36.54
Al_2O_3	0.26	
Fe_2O_3	0.20	
FeO	0.61	
MgO	62.78	63.46
CaO	0.18	
H_2O^+	0.05	
Total	100.60	100.00

(1) Hol Kol mine, North Korea; forsterite and spinel impurities. (2) $Mg_3(BO_3)_2$.

Occurrence: An uncommon mineral typically formed in the contact zone of magnesium-rich skarn borate deposits.

Association: Forsterite, clinohumite, ludwigite, spinel, fluoborite, szaibélyite (Hol Kol mine, North Korea); ludwigite, suanite, szaibélyite, warwickite (Neichi mine, Japan).

Distribution: From the Hol Kol Au–Cu mine, about 75 km southeast of Pyongyang, Suan Co., North Korea. In the Neichi mine, Miyako, Iwate Prefecture, Japan. At Qiliping, Hunan Province, and near Dading, Guizhou Province, China. In Russia, in the Korotkov skarn deposit, central Transbaikal, and at the Titovskoye boron deposit, Tas-Khayakhtakh Mountains, Sakha. From Băiţa (Rézbánya), Romania. In the Brosso mine, northwest of Ivrea, Torino, Italy. In the USA, on Jumbo Mountain, south of Darrington, Snohomish Co., Washington, and near Brighton, Big Cottonwood district, Salt Lake Co., Utah.

Name: To honor Professor Bundjiro Koto (1856–1935), Japanese geologist and petrographer, University of Tokyo, Tokyo, Japan, who studied the ore deposits of Hol Kol, North Korea.

Type Material: The Natural History Museum, London, England, 1938,1286; Harvard University, Cambridge, Massachusetts, 94750; National Museum of Natural History, Washington, D.C., USA, 103502.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 328–329. (2) Effenberger, H. and F. Pertlik (1984) Verfeinerung der Kristallstrukturen der isotypen Verbindungen $M_3(BO_3)_2$ mit M=Mg, Co und Ni (Strukturtyp, Kotoit). Zeits. Krist., 166, 129–140 (in German with English abs.). (3) Berger, S.V. (1949) The crystal structure of the isomorphous orthoborates of cobalt and magnesium. Acta Chem. Scand., 3, 660–675.