Chestermanite $Mg_2(Fe^{3+}, Mg, Al, Sb^{5+})O_2BO_3$

Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. Typically fibrous to asbestiform on [001], curved along {001} and flattened on {010}, to 2 mm. Crystals ubiquitously striated ∥ [011] and diamond-shaped in cross section. Of the nine forms noted, {110}, {210}, and {010} dominate.

Physical Properties: *Fracture:* Uneven to conchoidal, produced more easily ⊥ to length. *Tenacity:* Brittle, tougher than ludwigite. Hardness = 6 D(meas.) = 3.72(2) D(calc.) = 3.650

Optical Properties: Semitransparent. *Color:* Grayish green to black; surface (diffraction grating) iridescence is typical. *Streak:* Pale grayish green. *Luster:* Vitreous to silky. *Optical Class:* Biaxial (+). *Pleochroism:* X = dark greenish blue; Y = green; Z = pale yellowish brown. *Absorption:* $X \gg Y > Z$. $\alpha = 1.753$–1.759 $\beta = 1.763$–1.767 $\gamma = 1.791$–1.797 2V(meas.) = n.d. 2V(calc.) = 63°

Cell Data: *Space Group: Pbam.* $a = 18.525(4)$ $b = 12.272(2)$ $c = 3.0218(4)$ Z = 8

X-ray Powder Pattern: Twin Lakes region, California, USA; shows strong preferred {hk0} orientation.
5.114 (100), 2.559 (91), 2.169 (57), 2.746 (34), 1.9975 (32), 2.475 (19), 1.5300 (19)

Chemistry:

	(1)		(1)
Sb_2O_5	10.3	MgO	48.0
TiO_2	0.8	CaO	0.1
B_2O_3	[18.22]	F	0.1
Al_2O_3	5.3	$-O = F_2$	0.04
Fe_2O_3	16.0	Total	98.88
MnO	0.1		

(1) Twin Lakes region, California, USA; by electron microprobe, average of eight analyses, total Fe as Fe_2O_3, confirmed by Mössbauer spectroscopy, B_2O_3 calculated for stoichiometry; corresponds to $Mg_2(Fe^{3+}_{0.38}Mg_{0.28}Al_{0.20}Sb^{5+}_{0.12}Ti_{0.02})_{\Sigma=1.00}O_2B(O_{2.99}F_{0.01})_{\Sigma=3.00}$. (2) Do.; from crystal-structure analysis, corresponds to $Mg_{2.00}(Fe^{3+}_{0.43}Al_{0.16}Mg_{0.25}Sb_{0.13}Ti_{0.02})_{\Sigma=0.99}O_2BO_3$.

Mineral Group: Ludwigite group.

Occurrence: Rare, in veins and disseminated in a brucite marble lens contained in a multiply metamorphosed roof pendant between two plutons in a granodiorite batholith.

Association: Magnesian–aluminian ludwigite, magnesian calcite, fluoborite, wightmanite, spinel, brucite, safflorite, löllingite.

Distribution: From the north side of Kaiser Crest, about five km north of the easternmost end of Huntington Lake, Twin Lakes region, Fresno Co., California, USA.

Name: Honors Charles Wesley Chesterman (1913–1991), geologist and mineralogist, California Division of Mines and Geology, San Francisco, USA, who discovered the first specimens.

Type Material: National Museum of Natural History, Washington, D.C., USA, 160270, 165968.

References: (1) Erd, R.C. and E.E. Foord (1988) Chestermanite, a new member of the ludwigite–pinakiolite group from Fresno County, California. Can. Mineral., 26, 911–916. (2) (1990) Amer. Mineral., 75, 431 (abs. ref. 1). (3) Alfredsson, V., J.-O. Bovin, R. Norrestam, and O. Terasaki (1991) The structure of the mineral chestermanite, $Mg_{2.25}Al_{0.16}Fe_{0.43}Ti_{0.02}Sb_{0.13}O_2BO_3$. A combined single crystal X-ray and HREM study. Acta Chem. Scand., 45, 797–804. (4) Cooper, M.A. and F.C. Hawthorne (1998) The crystal structure of blatterite, $Sb^{5+}_3(Mn^{3+}, Fe^{3+})_9(Mn^{2+}, Mg)_{35}(BO_3)_{16}O_{32}$, and structural hierarchy in Mn^{3+}−bearing zigzag borates. Can. Mineral., 36, 1171–1193, esp. 1191.