Cummingtonite $(Mg,Fe^{2+})_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$

Crystal Data: Monoclinic. *Point Group:* $2/m$. As bladed, columnar, or fibrous crystals and fibrous aggregates, to 20 cm. *Twinning:* Simple or multiple twinning ∥ {100}.

Physical Properties: *Cleavage:* Good on {110}, intersecting at 54° and 126°. *Tenacity:* Brittle. Hardness = 5–6 D(meas.) = 3.1–3.6 D(calc.) = 3.3

Optical Properties: Transparent to translucent. *Color:* Dark green, brown, gray, beige; colorless to pale green in thin section. *Luster:* Vitreous.
Optical Class: Biaxial (+). *Pleochroism:* With increasing Fe content, weak; $X = Y =$ colorless; $Z =$ pale green. *Orientation:* $Y = b$; $Z \wedge c = -21°$ to $-16°$; $X \wedge a = -9°$ to $-3°$. *Dispersion:* $r < v$, weak. $\alpha = 1.632$–1.663 $\beta = 1.638$–1.677 $\gamma = 1.655$–1.697 2V(meas.) = 70°–90°

Cell Data: *Space Group:* $C2/m$. a = 9.516(5) $b = 18.139(10)$ $c = 5.311$ $\beta = 102.1°$ Z = 2

X-ray Powder Pattern: Labrador City, Canada.
8.30 (100b), 3.06 (90), 3.26 (80), 2.754 (70), 1.403 (60), 9.12 (50), 2.623 (50)

Chemistry:	(1)	(2)		(1)	(2)		(1)	(2)
SiO_2	51.53	53.84	FeO	16.91	25.63	Na_2O	0.65	0.15
TiO_2	0.31	0.01	MnO	0.22	0.19	K_2O	0.00	
Al_2O_3	5.02	1.61	MgO	20.84	17.44	H_2O^+	2.15	
Fe_2O_3	0.82		CaO	1.34	0.41	H_2O^-	0.64	
						Total	100.43	99.28

(1) Geodh Dubh, Scotland; corresponds to $(Mg_{4.44}Fe^{2+}_{2.02}Al_{0.21}Ca_{0.20}Na_{0.18}Fe^{3+}_{0.09}Ti_{0.03}Mn_{0.03})_{\Sigma=7.20}(Si_{7.36}Al_{0.64})_{\Sigma=8.00}O_{22}(OH)_{2.05}$. (2) Orfordville Formation, Mt. Cube quadrangle, Vermont, USA; by electron microprobe, corresponds to $(Mg_{3.77}Fe^{2+}_{3.11}Al_{0.08}Ca_{0.06}Na_{0.04}Mn_{0.02})_{\Sigma=7.08}(Si_{7.80}Al_{0.20})_{\Sigma=8.00}O_{22}(OH)_2$.

Polymorphism & Series: Forms a series with magnesio-cummingtonite and grunerite.

Mineral Group: Amphibole (Fe–Mn–Mg) group: 0.3 $Mg/(Mg + Fe^{2+})$ 0.69; $(Ca + Na)_B < 1.34$; Li < 1.0; Mn < 0.5.

Occurrence: Commonly in medium-grade regionally metamorphosed rocks; characteristic of metamorphosed iron formations; a late-stage mineral in some gabbros and norites; rarely in silicic volcanic rocks.

Association: "Hornblende," anthophyllite, actinolite, ferro-actinolite, tremolite, arfvedsonite, magnesio-arfvedsonite, gedrite, glaucophane, quartz, garnet.

Distribution: Well-characterized material from: in the USA, at Cummington, Hampshire Co., Massachusetts; the Homestake mine, Lead, Pennington Co., South Dakota; in the Jackson County Iron Formation, Wisconsin. In the Wabush Iron Formation, Labrador City, Labrador, Newfoundland, Canada. From the Miyamori district, Iwate Prefecture, and the Hitachi mine, Ibaragi Prefecture, Japan. In the Garabal Hill-Glen Fyne complex, Scotland. At Teisko, Finland. From Nordmark, Värmland, Sweden.

Name: For the occurrence at Cummington, Massachusetts, USA.

References: (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 386, 390. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) Rock-forming minerals, v. 2, chain silicates, 235–248. (3) Ghose, S. (1961) The crystal structure of a cummingtonite. Acta Cryst., 14, 622–627. (4) Klein, C. (1964) Cummingtonite-grunerite series: a chemical, optical and X-ray study. Amer. Mineral., 49, 963–982. (5) Spear, F.S. (1980) The gedrite-anthophyllite solvus and the composition limits of orthoamphibole from the Post Pond Volcanics, Vermont. Amer. Mineral., 65, 1103–1118. (6) Ghose, S. and Y. Hexiong (1989) Mn-Mg distribution in a C2/m manganoan cummingtonite: crystal-chemical considerations. Amer. Mineral., 74, 1091–1096. (7) Phillips, W.R. and D.T. Griffen (1981) Optical mineralogy, 225–258.