Chloritoid $(Fe^{2+}, Mg, Mn)_2Al_4Si_2O_{10}(OH)_4$

Crystal Data: Monoclinic or triclinic, both pseudohexagonal. *Point Group:* $2/m$ or 1. Rarely as rosettes of pseudohexagonal tabular crystals; commonly coarsely foliated with foliae typically curved or bent; massive. *Twinning:* Common on {001}, may be lamellar; twin axes [100], [110], and [130] observed.

Physical Properties: *Cleavage:* Perfect on {001}, distinct on {110}; parting on {010}. *Tenacity:* Brittle. Hardness = 6.5 D(meas.) = 3.46–3.80 D(calc.) = 3.56

Optical Properties: Translucent. *Color:* Dark gray, greenish gray, greenish black; colorless to green in thin section. *Streak:* White, grayish, or very slightly greenish. *Luster:* Somewhat pearly on cleavage surfaces.
Optical Class: Biaxial (+) or (–). *Pleochroism:* X = olive-green to yellow; Y = grayish blue to blue; Z = colorless to pale greenish yellow. *Orientation:* X or $Y = b$ (monoclinic); $Z \wedge c = 2°–30°$; $Y \simeq b$ (triclinic). *Dispersion:* $r > v$, strong. $\alpha = 1.705–1.730$ $\beta = 1.708–1.734$ $\gamma = 1.712–1.740$ 2V(meas.) = ∼45°–70°

Cell Data: *Space Group:* $C2/c$. a = 9.50(3) $b = 5.50(2)$ $c = 18.22(5)$ $\beta = 101°57(5)'$ Z = 4, or *Space Group:* $C\overline{1}$. a = 9.46(1) $b = 5.50(1)$ $c = 9.15(1)$ $\alpha = 97.05(2)°$ $\beta = 101.56(2)°$ $\gamma = 90.10(2)°$ Z = 4

X-ray Powder Pattern: Natick, Rhode Island, USA.
4.498 (100), 4.449 (100), 2.963 (90), 1.5813 (80), 2.367 (70), 2.306 (70), 2.639 (50)

Chemistry:

	(1)		(1)
SiO_2	23.91	CaO	0.04
TiO_2	0.20	Na_2O	0.00
Al_2O_3	40.12	K_2O	trace
Fe_2O_3	1.23	F	0.01
FeO	27.06	H_2O^+	7.03
MnO	0.16	H_2O^-	0.01
MgO	0.51	Total	100.28

(1) Natick, Rhode Island, USA; corresponds to $(Fe^{2+}_{1.89}Mg_{0.06}Mn_{0.01})_{\Sigma=1.96}(Al_{3.95}Fe^{3+}_{0.08}Ti_{0.01})_{\Sigma=4.04}Si_{2.00}O_{9.80}(OH)_{3.20}$.

Polymorphism & Series: Forms a series with carboirite; monoclinic and triclinic polytypes are known.

Mineral Group: Chloritoid group.

Occurrence: In regionally metamorphosed pelitic sediments and schists in the biotite, garnet, and lower grade staurolite zones; in quartz-carbonate veins and other hydrothermal environments.

Association: Muscovite, chlorite, staurolite, garnet, kyanite, quartz, mica, rutile.

Distribution: A widely distributed mineral; only a few studied occurrences are noted. In Russia, from Kosoi Brod, Mramorskii Zavod, south of Yekaterinburg (Sverdlovsk), Ural Mountains. At Salmchâteau, near Ottré, Ardennes Mountains, Belgium. From Nadels and Zermatt, Valais, Switzerland. At Prägraten, Tirol, Austria. In Scotland, along the coast between Stonehaven and Aberdeen; and from Unst, Shetland Islands. Around Tintagel, Cornwall, England. In the USA, at Natick, Kent Co., Rhode Island; Chester, Hampden Co., Massachusetts; in Clove Valley, Duchess Co., New York; from Bull Mountain, Patrick Co., Virginia. In Canada, at Chibougamau and St. Giles, Quebec. From Kalgoorlie, Western Australia.

Name: For its resemblance to members of the *chlorite* group.

References: (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 640–642. (2) Deer, W.A., R.A. Howie, and J. Zussman (1982) Rock-forming minerals, (2nd edition), v. 1A, orthosilicates, 867–912. (3) Halferdahl, L.B. (1961) Chloritoid: its composition, X-ray and optical properties, stability and occurrence. J. Petrol., 2, 49–135. (4) Hanscomb, R.H. (1980) The structure of triclinic chloritoid and chloritoid polymorphism. Amer. Mineral., 65, 534–539.