## Clinochlore $(Mg, Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$



**Crystal Data:** Monoclinic. *Point Group:* $2/m$. In thin to thick pseudohexagonal crystals, with tapering pyramidal faces, to 10 cm. Commonly foliated, fibrous, granular, earthy, massive. *Twinning:* Twin plane {001}; twin axis [310], composition plane {001}.

**Physical Properties:** *Cleavage:* {001}, perfect. *Tenacity:* Laminae flexible, inelastic. Hardness = 2–2.5 D(meas.) = 2.60–3.02 D(calc.) = 2.628

**Optical Properties:** Transparent to translucent. *Color:* Grass-green, olive-green, yellowish, white; pink, rose-red; colorless to pale green or yellow in thin section. *Streak:* Greenish white to white. *Luster:* Pearly, greasy, dull.
*Optical Class:* Biaxial (+) or (–). *Pleochroism:* Distinct; $X$ = light yellow-green to light blue-green; $Y = Z$ = light greenish yellow to light blue-green. *Orientation:* $Y = b$; $Z \wedge c = 2°$–$9°$. *Dispersion:* $r < v$. *Absorption:* $Y \simeq Z > X$ or $Z \simeq Y > Z$. $\alpha = 1.571$–$1.588$ $\beta = 1.571$–$1.588$ $\gamma = 1.576$–$1.597$ 2V(meas.) = 0°–50°

**Cell Data:** *Space Group:* $C2/m$. $a = 5.350(3)$ $b = 9.267(5)$ $c = 14.27(1)$ $\beta = 96.35(5)°$ Z = 2

**X-ray Powder Pattern:** Synthetic (IIb structure); berthierine plus clinochlore easily mistaken for chamosite.
3.57 (100), 2.540 (100), 2.008 (100), 1.539 (100), 14.1 (80), 7.14 (80), 4.76 (80)

**Chemistry:**

| | (1) | (2) | | (1) | (2) |
|---|---|---|---|---|---|
| $SiO_2$ | 33.83 | 32.12 | MgO | 34.94 | 35.36 |
| $Al_2O_3$ | 12.95 | 9.50 | CaO | | 1.24 |
| $Fe_2O_3$ | 2.25 | | $H_2O^+$ | 13.11 | 10.25 |
| $Cr_2O_3$ | | 7.88 | $H_2O^-$ | | 2.04 |
| FeO | 3.02 | 1.98 | Total | 100.10 | 100.37 |

(1) Zillertal, Austria; corresponds to $(Mg_{4.94}Fe^{2+}_{0.24})_{\Sigma=5.18}(Al_{0.65}Fe^{3+}_{0.16})_{\Sigma=0.81}(Si_{3.21}Al_{0.79})_{\Sigma=4.00}O_{10}(OH)_8$. (2) Deer Park, Wyoming, USA; corresponds to $(Mg_{5.05}Fe^{2+}_{0.16}Ca_{0.13})_{\Sigma=5.34}(Cr_{0.60}Al_{0.15}Fe^{3+}_{0.15})_{\Sigma=0.90}(Si_{3.08}Al_{0.92})_{\Sigma=4.00}O_{10}(OH)_8$.

**Polymorphism & Series:** Forms a series with chamosite; stacking disorder is common.

**Mineral Group:** Chlorite group.

**Occurrence:** A hydrothermal alteration product of amphiboles, pyroxenes, biotite. In chlorite schists, serpentinites, marbles, calc-silicate rocks, amphibolites, less commonly in ultramafic rocks. In ore veins; a detrital component of sediments.

**Association:** Serpentine, calcite, dolomite, actinolite, biotite, olivine, plagioclase, talc, chromite, uvarovite.

**Distribution:** Some localities for well-crystallized material are: in the USA, in the Emery mine, Chester, Hampden Co., Massachusetts; at Texas, Lancaster Co., and West Chester, Chester Co., Pennsylvania; in the Tilly Foster mine, Brewster, Putnam Co., New York. In the Zillertal, Tirol, Austria. From the Pfitschtal, Trentino-Alto Adige; Val Malenco, Lombardy; and at Ala, Piedmont, Italy. At Rimpfischwänge, near Zermatt, Valais, Switzerland. From Ojén, Málaga Province, Spain. On Unst, Shetland Islands, Scotland. In the Kop Krom [chrome mine], Kop Mountains, near Aşkale, Turkey. In Russia, in the Ural Mountains, at Akhmatovsk, Berbliouchka, and Hardadinsk; and at Miass, Ilmen Mountains, Southern Ural Mountains.

**Name:** For its inclined optic axes and the Greek *chloros*, for green, its common color.

**References:** (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 644–650, 650–653 [penninite, kämmererite]. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) Rock-forming minerals, v. 3, sheet silicates, 131–163. (3) Bayliss, P. (1975) Nomenclature of the trioctahedral chlorites. Can. Mineral., 13, 178–180. (4) Rule, A.C. and S.W. Bailey (1987) Refinement of the crystal structure of a monoclinic ferroan clinochlore. Clays and Clay Minerals, 35, 129–138.