Tremolite $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Elongated, stout prismatic, or flattened bladed crystals, to 20 cm; also fibrous, granular or columnar aggregates. *Twinning:* Simple or multiple, common ∥ {100}; rarely multiple ∥ {001}.

Physical Properties: *Cleavage:* Perfect on {110}, intersecting at 56° and 124°; partings on {010}, {100}. *Tenacity:* Brittle. Hardness = 5–6 D(meas.) = 2.99–3.03 D(calc.) = 2.964

Optical Properties: Transparent to translucent. *Color:* White, gray, lavender to pink; colorless in thin section. *Luster:* Vitreous.
Optical Class: Biaxial (–). *Orientation:* $Y = b$; $Z \wedge c = -21°$ to $-19°$; $X \wedge a = -6°$ to $-4°$. *Dispersion:* $r < v$, weak. α = 1.605–1.613 β = 1.616–1.624 γ = 1.630–1.636 2V(meas.) = 86°–88°

Cell Data: *Space Group:* $C2/m$. $a = 9.863(1)$ $b = 18.048(2)$ $c = 5.285(1)$ $\beta = 104.79(1)°$ Z = 2

X-ray Powder Pattern: St. Gotthard, Switzerland.
8.38 (100), 3.121 (100), 2.705 (90), 3.268 (75), 1.892 (50), 2.805 (45), 2.015 (45)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	56.57	59.30	Na_2O	1.44	2.07
TiO_2	0.01	trace	K_2O	0.68	0.61
Al_2O_3	1.41	0.26	F	1.52	3.84
FeO	0.08	trace	Cl	0.05	trace
MnO	0.03	trace	H_2O^+	1.46	0.50
MgO	24.41	24.58	$-O = (F,Cl)_2$	[0.64]	[1.62]
CaO	12.25	12.03	Total	[99.27]	[101.57]

(1) Gouverneur, New York, USA; Fe_2O_3 trace; corresponds to $(Ca_{1.80}Na_{0.38}K_{0.12})_{\Sigma=2.30}(Mg_{5.00}Fe^{2+}_{0.01})_{\Sigma=5.00}(Si_{7.77}Al_{0.23})_{\Sigma=8.00}O_{22}[(OH)_{1.34}F_{0.66}Cl_{0.01}]_{\Sigma=2.01}$. (2) Balmat No. 3 mine, St. Lawrence Co., New York; by electron microprobe, original total given as 101.47%; corresponds to $(Ca_{1.74}Na_{0.54}K_{0.10})_{\Sigma=2.38}(Mg_{4.95}Al_{0.04})_{\Sigma=4.99}Si_{8.01}O_{22}[F_{1.64}(OH)_{0.35}Cl_{0.01}]_{\Sigma=2.00}$.

Polymorphism & Series: Forms a series with actinolite and ferro-actinolite.

Mineral Group: Amphibole (calcic) group: $Mg/(Mg + Fe^{2+}) \geq 0.90$; $(Na + K)_A < 0.5$; $Na_B < 0.67$; $(Ca + Na)_B \geq 1.34$; $Si \geq 7.5$.

Occurrence: From contact metamorphism of Ca-Mg siliceous sediments; in greenschist facies metamorphics derived from ultramafic or magnesium carbonate rocks.

Association: Calcite, dolomite, calcian garnet, wollastonite, talc, diopside, forsterite, cummingtonite, magnesio-cummingtonite, riebeckite, winchite.

Distribution: Notable localities include: on Campolungo Alp, Ticino, and Bristenstock, Uri, Switzerland. From St. Marcel, Piedmont, Italy. At Bilin, Czech Republic. In the USA, from Pierrepont, Gouverneur, Edwards, and Macomb, St. Lawrence Co., New York; at Franklin, Sussex Co., New Jersey; and Lee, Berkshire Co., Massachusetts. At Wilberforce, Ontario, Canada. From Kozano, Badakhshan Province, Afghanistan. At Lelatema, Tanzania. In the Brumado mine, Bahia, Brazil.

Name: For an occurrence in the Tremola Valley, southern St. Gotthard Mountains, Switzerland.

References: (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 385–398. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) Rock-forming minerals, v. 2, chain silicates, 249–262. (3) Hawthorne, F.C. and H.D. Grundy (1976) The crystal chemistry of the amphiboles: IV. X-ray and neutron refinements of the crystal structure of tremolite. Can. Mineral., 14, 334–345. (4) Petersen, E.U., E.J. Essene, D.R. Peacor, and J.W. Valley (1982) Fluorine end-member micas and amphiboles. Amer. Mineral., 67, 538–544. (5) Walitzi, E.M. and K. Ettinger (1986) Verfeinerung der Kristallstruktur eines Tremolites vom Ochsenkogel (Gleinalpe/Styria), Österreich. Neues Jahrb. Mineral., Monatsh., 360–366 (in German). (6) Phillips, W.R. and D.T. Griffen (1981) Optical mineralogy, 229–231.