Norbergite $Mg_3(SiO_4)(F,OH)_2$

Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. Crystals rare, to 2.5 cm, thick tabular, typically rounded and highly modified; granular.

Physical Properties: *Fracture:* Uneven to subconchoidal. *Tenacity:* Brittle. Hardness = 6–6.5 D(meas.) = 3.177 D(calc.) = 3.186 May fluoresce canary-yellow under SW UV.

Optical Properties: Transparent to translucent. *Color:* Tan, yellow, yellow-orange, orange-brown, pink with purplish tint, white; in thin section, pale yellow to colorless. *Luster:* Vitreous to resinous.
Optical Class: Biaxial (+). *Pleochroism:* X = pale yellow; Y = very pale yellow; Z = colorless. *Orientation:* $X = a$; $Y = c$; $Z = b$. *Dispersion:* $r > v$, slight. $\alpha = 1.563$–1.567 $\beta = 1.567$–1.579 $\gamma = 1.590$–1.593 2V(meas.) = 44°–50°

Cell Data: *Space Group: Pmcn.* $a = 8.747(6)$ $b = 4.710(4)$ $c = 10.271(8)$ $Z = 4$

X-ray Powder Pattern: Synthetic $Mg_3SiO_4F_2$.
3.058 (100), 2.230 (80), 2.639 (75), 2.255 (70), 1.7241 (50), 1.4763 (45), 2.408 (35)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	27.56	29.74	MgO	59.35	58.73
TiO_2	0.01	0.42	CaO		0.15
Al_2O_3	0.11		F	13.49	16.77
Fe_2O_3	0.28		H_2O^+	2.68	1.52
FeO	1.91	0.06	H_2O^-	0.00	
MnO	0.12	0.01	$-O = F_2$	5.68	7.07
ZnO		0.05	Total	99.83	100.38

(1) Norberg, Sweden; corresponds to $(Mg_{3.01}Fe^{2+}_{0.05}Fe^{3+}_{0.01})_{\Sigma=3.07}Si_{0.94}O_4[F_{1.45}(OH)_{0.61}]_{\Sigma=2.06}$.
(2) Franklin, New Jersey, USA; by electron microprobe, corresponds to $Mg_{2.93}Si_{1.00}O_4[F_{1.77}(OH)_{0.34}]_{\Sigma=2.11}$.

Mineral Group: Humite group.

Occurrence: In contact metamorphic zones in limestones and dolostones into which plutonic rocks or pegmatites have introduced fluorine.

Association: Dolomite, calcite, tremolite, grossular, wollastonite, forsterite, monticellite, cuspidine, fluoborite, ludwigite, fluorite, phlogopite.

Distribution: In the Östanmossa and other iron mines, Norberg, Västmanland, Sweden. At Piukkala, near Pargas, Finland. Near Loch Ness, Inverness-shire, Scotland. From the Nicoll quarry, Franklin, Sussex Co., New Jersey. Around Edenville, Orange Co., and in the Balmat mines, St. Lawrence Co., New York, USA. At Monte Somma and Nocera, Campania, Italy.

Name: From its first locality at Norberg, Sweden.

Type Material: n.d.

References: (1) Geijer, P. (1926) Norbergite and fluoborite, two new minerals from the Norberg mining district. Geol. Fören. Förhandl. Stockholm, 48, 84–85. (2) Deer, W.A., R.A. Howie, and J. Zussman (1982) Rock-forming minerals, (2nd edition), v. 1A, orthosilicates, 379–417. (3) Gibbs, G.V. and P.H. Ribbe (1969) The crystal structure of the humite minerals: I. Norbergite. Amer. Mineral., 54, 376–390. (4) (1960) NBS Circ. 539, 10, 39.