Macfallite $Ca_2Mn^{3+}_3(SiO_4)(Si_2O_7)(OH)_3$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Rare single crystals, elongated, to 1 cm, invariably twinned; as radial and framboidal aggregates; in fine intergrowths with orientite; massive. *Twinning:* By reflection on {100}, commonly repeated.

Physical Properties: *Cleavage:* Perfect on {001}. Hardness = 5–5.5 D(meas.) = 3.43(2) D(calc.) = 3.53

Optical Properties: Transparent to translucent. *Color:* Reddish brown, maroon, dull pink. *Streak:* Brown with a reddish tint. *Luster:* Silky to subadamantine. *Optical Class:* Biaxial (+) or (–). *Pleochroism:* X = colorless to yellow; Y = light brown; Z = dark brown to reddish brown. *Orientation:* $Y = b$. α = 1.773–1.775 β = 1.795 γ = 1.810–1.815 2V(meas.) = Very large.

Cell Data: *Space Group:* $P2_1/m$. a = 10.235(3) b = 6.086(6) c = 8.970(5) $\beta = 110.75(3)^\circ$ Z = 2

X-ray Powder Pattern: Manganese Lake, Michigan, USA.
2.70 (100), 4.76 (90), 1.588 (85), 3.904 (80), 3.40 (70), 2.97 (70), 2.18 (70)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	32.04	33.88	MnO	0.69	
TiO_2	trace		CuO	1.13	
Al_2O_3	3.95	1.03	MgO	0.39	0.73
Fe_2O_3	0.18		CaO	19.75	20.40
Cr_2O_3	0.03		K_2O	0.12	
Mn_2O_3	35.96	41.47	Na_2O	0.03	
V_2O_5	0.28		H_2O	5.39	[2.49]
			Total	99.94	[100.00]

(1) Manganese Lake, Michigan, USA; corresponds to $(Ca_{1.93}Mn^{2+}_{0.05})_{\Sigma=1.98}(Mn^{3+}_{2.49}Al_{0.42}Cu_{0.08}Fe^{3+}_{0.01})_{\Sigma=3.00}(Si_{2.92}V_{0.02})_{\Sigma=2.94}O_{11}[(OH)_{2.66}(H_2O)_{0.34}]_{\Sigma=3.00}$. (2) Faggiona, Italy; by electron microprobe, average of eight analyses, H_2O by difference.

Occurrence: In abundance, replacing calcite in fissures and in lenses in basalt (Manganese Lake, Michigan, USA); replacing braunite under low-temperature metamorphic conditions (Faggiona, Italy).

Association: Manganite, braunite, orientite, pyrolusite (Manganese Lake, Michigan, USA); braunite, quartz, manganoan richterite, carbonates (Faggiona, Italy).

Distribution: From near Manganese Lake, Copper Harbor, Keweenaw Co., Michigan, USA. In Italy, in the Cerchiara mine, Faggiona, La Spezia, Liguria.

Name: For Russell P. MacFall, American amateur mineralogist.

Type Material: National Museum of Natural History, Washington, D.C., USA, 135923; The Natural History Museum, London, England, 1984,139.

References: (1) Moore, P.B., J. Ito, and I.M. Steele (1979) MacFallite and orientite: calcium manganese (III) silicates from upper Michigan. Mineral. Mag., 43, 325–331. (2) (1980) Amer. Mineral., 65, 406 (abs. ref. 1). (3) Moore, P.B., J. Shen, and T. Araki (1985) Crystal chemistry of the $^2_\infty[M^{3+}_2\Phi_2(TO_4)_2]$ sheet: structural principles and crystal structures of ruizite, macfallite and orientite. Amer. Mineral., 70, 171–181. (4) Basso, R., G. Lucchetti, and A. Palenzona (1989) Orientite and macfallite: new occurrence at the Cerchiara mine (eastern Liguria, Italy). Neues Jahrb. Mineral., Monatsh., 455–460.