Marokite $CaMn_2^{3+}O_4$

Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$ or $mm2$. Crystals prismatic, to 5 cm, flattened on {010}, with {120}, {110}, {201}, and {011} prominent; may be fibrous, in dense groups.

Physical Properties: *Cleavage:* Perfect on {100}; good on {001}. Hardness = 6.5 VHN = 800 D(meas.) = 4.64(2) D(calc.) = 4.63(4)

Optical Properties: Opaque, translucent through thin edges. *Color:* Black; in reflected light, gray to brown, with carmine-red internal reflections. *Streak:* Reddish brown. *Luster:* Adamantine.
Optical Class: Biaxial (–). *Pleochroism:* Very strong; X = safflower-red. *Orientation:* $X = c$. α = n.d. β = n.d. γ = n.d. 2V(meas.) = 20°–25° *Anisotropism:* Strong; yellowish green to greenish yellow. *Bireflectance:* Yellowish gray to gray-brown.
R_1–R_2: (400) 20.2–22.9, (420) 19.3–21.9, (440) 18.4–20.9, (460) 17.7–20.0, (480) 17.0–19.3, (500) 16.5–18.7, (520) 16.2–18.3, (540) 16.0–18.2, (560) 16.0–18.4, (580) 16.0–18.7, (600) 15.9–18.6, (620) 15.7–18.3, (640) 15.5–18.0, (660) 15.4–17.8, (680) 15.2–17.5, (700) 15.1–17.3

Cell Data: *Space Group:* $Pmab$ or $P2_1ab$. a = 9.71(2) b = 10.03(2) c = 3.162(5) Z = 4

X-ray Powder Pattern: Tachgagalt, Morocco.
2.71 (FF), 2.22 (FF), 2.29 (F), 2.07 (F), 2.87 (M), 2.56 (M), 1.63 (M)

Chemistry:

	(1)	(2)	(3)
SiO_2	0.62		
MnO_2	38.94	40.88	40.63
Fe_2O_3	1.60		
MnO	31.38	32.95	33.16
MgO	0.15		
CaO	25.60	26.17	26.21
Na_2O	0.30		
F	0.20		
H_2O^+	0.28		
H_2O^-	0.17		
CO_2	0.52		
Total	99.76	[100.00]	100.00

(1) Tachgagalt, Morocco. (2) Do.; recalculated to 100% after deduction of impurities.
(3) $CaMn^{4+}Mn^{2+}O_4$ (crystal-structure analysis of type material determined $CaMn_2^{3+}O_4$).

Occurrence: In hydrothermal manganese oxide deposits.

Association: Jouravskite, hausmannite, braunite, cryptomelane, pyrolusite, crednerite, dolomite, barite, calcite (Tachgagalt, Morocco); pyrolusite, cryptomelane, "opal" (Kuruman, South Africa).

Distribution: From Tachgagalt, 17 km south of Ouarzazate, Anti-Atlas Mountains, Morocco. In the Black Rock mine, near Kuruman, Cape Province, South Africa.

Name: For the first occurrence in Morocco, *Maroc* in French.

Type Material: Geological Survey, Rabat, Morocco; National School of Mines, Paris, France.

References: (1) Gaudefroy, C., G. Jouravsky, and F. Permingeat (1963) La marokite, $CaMn_2O_4$, une nouvelle espèce minérale. Bull. Soc. fr. Minéral., 86, 359–367 (in French). (2) (1964) Amer. Mineral., 49, 817 (abs. ref. 1). (3) Lepicard, G. and J. Protas (1966) Étude structurale de l'oxyde double de manganèse et de calcium orthorhombique $CaMn_2O_4$ (marokite). Bull. Soc. fr. Minéral., 89, 318–324 (in French). (4) De Villiers, P.R. and F.H. Herbstein (1968) Second occurrence of marokite. Amer. Mineral., 53, 495–496.