Mannardite $BaTi_6(V^{3+},Cr^{3+})_2O_{16}\cdot H_2O$

Crystal Data: Tetragonal. *Point Group:* $4/m$. Crystals prismatic, bounded by {110} and {001}, may be doubly-terminated; elongated along [001], flattened on {100}, bent or twisted about [001], deeply striated ‖ elongation, to 5 mm; in fanlike aggregates.

Physical Properties: *Cleavage:* {100}, good. *Fracture:* Uneven to subconchoidal. *Tenacity:* Brittle. Hardness = 5.5–7 VHN = 609 D(meas.) = 4.12–4.43 D(calc.) = 4.28

Optical Properties: Opaque. *Color:* Jet-black; pale reddish brown in reflected light. *Streak:* White to grayish white. *Luster:* Adamantine.
Optical Class: Uniaxial (+). *Anisotropism:* Strong; light pinkish gray to dark brownish gray. *Bireflectance:* Distinct; light to dark brown.
R_1–R_2: (400) 16.5–18.0, (420) 16.3–17.6, (440) 16.0–17.2, (460) 15.7–17.0, (480) 15.5–16.9, (500) 15.4–17.0, (520) 15.2–17.2, (540) 15.1–17.4, (560) 15.0–17.7, (580) 15.0–17.9, (600) 15.0–18.1, (620) 15.0–18.3, (640) 15.0–18.4, (660) 15.0–18.5, (680) 15.1–18.6, (700) 15.1–18.6

Cell Data: *Space Group:* $I4_1/a$. $a = 14.357(2)$ $c = 5.908(1)$ $Z = 4$

X-ray Powder Pattern: Rough claims, Canada; close to redledgeite.
3.201 (100), 1.586 (80), 2.473 (70), 1.887 (70), 2.224 (50), 1.690 (50), 1.394 (40)

Chemistry:

	(1)	(2)		(1)	(2)
TiO_2	60.1	60.2	Cr_2O_3	1.9	1.9
Fe_2O_3		3.7	BaO	19.4	19.8
V_2O_3	16.3	12.2	H_2O	[2.2]	[2.2]
			Total	[99.9]	[100.0]

(1) Rough claims, Canada; by electron microprobe, H_2O calculated + Ba = 2; corresponds to $Ba_{1.02}(Ti_{6.03}V_{1.75}Cr_{0.20})_{\Sigma=7.98}O_{16}\cdot 0.98H_2O$. (2) Bathurst, Canada; by electron microprobe, H_2O calculated + Ba = 2; corresponds to $Ba_{1.04}(Ti_{6.07}V_{1.32}Fe_{0.38}Cr_{0.20})_{\Sigma=7.97}O_{16}\cdot 0.96H_2O$.

Mineral Group: Cryptomelane group.

Occurrence: In late-stage quartz-carbonate veins cutting shale and siltstone (Rough claims, Canada); in an orebody in faulted metasediments and iron formation (Bathurst, Canada); in a silver-bearing polymetallic deposit (Kantsi, China); in kimberlite (Star mine, South Africa).

Association: Barytocalcite, norsethite, sulvanite, barite, quartz (Rough claims, Canada); edingtonite, harmotome, barytocalcite, siderite, sphalerite, quartz (Bathurst, Canada).

Distribution: On the Rough claims, north of Sifton Pass, British Columbia, and in the Brunswick No. 12 orebody, Bathurst, New Brunswick, Canada. In China, from Kantsi, Sichuan Province. In the Star mine, Free State, South Africa.

Name: Honors Dr. George William Mannard (1932–1982), formerly President of Kidd Creek Mines, Ltd., Toronto, Canada, for his interest in the mineral deposits of British Columbia.

Type Material: Geological Survey of Canada, Ottawa, 64197; Royal Ontario Museum, Toronto, Canada, M40292, M40293; The Natural History Museum, London, England, 1983,68 and 1983,69; National Museum of Natural History, Washington, D.C., USA, 150275, 150337, 162567.

References: (1) Scott, J.D. and G.R. Peatfield (1986) Mannardite $[Ba\cdot H_2O](Ti_6V^{3+})_2O_{16}$, a new mineral species, and new data on redledgeite. Can. Mineral., 24, 55–66. (2) (1988) Amer. Mineral., 73, 193 (abs. ref. 1). (3) Szymański, J.T. (1986) The crystal structure of mannardite, a new hydrated cryptomelane-group (hollandite) mineral with a doubled short axis. Can. Mineral., 24, 67–78.