Braunite $Mn^{2+}Mn_6^{3+}SiO_{12}$

Crystal Data: Tetragonal. *Point Group:* $4/m\ 2/m\ 2/m$. As pyramidal crystals, to 5 cm, striated on {001} and {201} ‖ [010]; also dense granular, massive. *Twinning:* On {112}.

Physical Properties: *Cleavage:* Perfect on {112}. *Fracture:* Uneven to subconchoidal. *Tenacity:* Brittle. Hardness = 6–6.5 VHN = 920–1079, 1025–1196 (100 g load). D(meas.) = 4.72–4.83 D(calc.) = [4.86] Weakly magnetic.

Optical Properties: Opaque. *Color:* Dark, brownish black to steel-gray; in polished section, greyish white with a brownish tinge. *Streak:* Brownish black to steel-gray. *Luster:* Submetallic. *Anisotropism:* Weak in air to distinct in oil, dark to lighter slate gray.
R_1–R_2: (400) 23.4–25.4, (420) 22.7–24.5, (440) 22.0–23.6, (460) 21.5–22.9, (480) 21.0–22.4, (500) 20.5–21.9, (520) 20.0–21.5, (540) 19.6–21.2, (560) 19.3–20.9, (580) 19.0–20.6, (600) 18.8–20.3, (620) 18.6–20.0, (640) 18.5–19.8, (660) 18.3–19.6, (680) 18.2–19.5, (700) 18.1–19.4.

Cell Data: *Space Group:* $I4_1/acd$. $a = 9.36$–9.45 $c = 18.60$–18.97 $Z = 8$

X-ray Powder Pattern: Thuringia, Germany.
2.72 (100), 1.656 (70), 2.14 (50), 2.35 (40), 1.420 (40), 1.074 (40), 3.49 (30)

Chemistry:	(1)	(2)	(3)		(1)	(2)	(3)
SiO_2	9.89	9.68	9.94	FeO	3.81		
TiO_2		0.09		MnO	78.91	[10.80]	11.73
Al_2O_3		0.35		MgO	0.15	0.13	
Fe_2O_3		2.02		CaO	0.34	0.38	
Mn_2O_3		[75.80]	78.33	O	7.35		
				Total	100.45	[99.25]	100.00

(1) Långban, Sweden; total Mn as MnO. (2) Tirodi, India; by electron microprobe, Mn^{2+} estimated equal to (Si + Al + Ti) − (Mg + Ca). (3) $Mn^{2+}Mn_6^{3+}SiO_{12}$.

Polymorphism & Series: Forms a series with abswurmbachite.

Occurrence: Formed by metamorphism of manganese silicates and oxides; also a product of weathering.

Association: Pyrolusite, jacobsite, hausmannite, bixbyite, rhodonite, spessartine, hematite.

Distribution: Of widespread origin; a few localities for large crystals or pure material are: in Germany, at Öhrenstock and Elgersburg, near Ilmenau, Thuringia, and at Ilfeld, Harz Mountains. From Långban, and Jakobsberg, Värmland, Sweden. In Norway, at Botnedalen. In Italy, at St. Marcel, Val d'Aosta. From Kacharwali, Nagpur district, Maharashtra, and Tirodi, Madhya Pradesh, India. In Brazil, at Miguel Burnier, near Ouro Prêto, Minas Gerais. From mines in the Kalahari manganese field, around Kuruman, Cape Province, South Africa. In the USA, at the Spiller manganese mines, 25 km northeast of Mason, Mason Co., Texas; in the Batesville district, Independence Co., Arkansas; at Cartersville, Bartow Co. Georgia; from Snowmass, Pitkin Co., Colorado; in the Black Diablo mine, Pershing Co., Nevada; and the Fort Seward mine, Humboldt Co., California.

Name: To honor Kammerrath [Advisor of the Chambers] Braun of Gotha, Germany.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 551–554. (2) Moore, P.B. and T. Araki (1976) Braunite: its structure and relationship to bixbyite, and some insights on the genealogy of fluorite derivative structures. Amer. Mineral., 61, 1226–1240. (3) Dasgupta, H.C. and R. Manickavasagam (1981) Chemical and X-ray investigation of braunite from the metamorphosed manganiferous sediments of India. Neues Jahrb. Mineral., Abh., 142, 149–160. (4) Bhattacharyya, P.K., S. Dasgupta, M. Fukuoka, and S. Roy (1984) Geochemistry of braunite and associated phases in metamorphosed non-calcareous manganese ores of India. Contr. Mineral. Petrol., 87, 65–71. (5) Berry, L.G. and R.M. Thompson (1962) X-ray powder data for the ore minerals. Geol. Soc. Amer. Mem. 85, 177.